AERO ENGINEERING

A COMPREHENSIVE WORK FOR THOSE ENGAGED
IN THE PRODUCTION, ASSEMBLY, TESTING,
MAINTENANCE, AND OVERHAUL OF AIRCRAFT

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VOLUME III—PART I

MAINTENANCE AND OVERHAUL

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"GIPSY MAJOR" AERO ENGINE

SECTION I—RUNNING INSTRUCTIONS

By A. J. BRANT

Service Manager, de Havilland Aircraft Co. Ltd.

THE Gipsy Major is a four-cylinder, inverted, air-cooled, direct drive engine, manufactured by the de Havilland Aircraft Company Limited.

Leading particulars of the engine are given in tabular form on the next page.

In the present section no attempt will be made to deal in detail with the constructional side. This will form the subject of a separate article. Here we will deal chiefly with operation and maintenance from the point of view of the ground engineer.

Lubrication

Oil is drawn from a separate tank by a gear type pump situated on the timing cover and driven by a gear which meshes with the camshaft wheel. The oil pressure is regulated to 40–45 lbs. per sq. in. by an adjustable relief valve in the cover of the pump casing. From the pump, the oil under pressure flows through a gauze or alternatively a " Tecalemit " felt filter which ensures the removal of the finest particles of foreign matter before the oil passes to the engine.

This filter is positioned on the timing gear cover and is easily removed either for cleaning or for renewal of the element. From the filter the main supply is taken to an external gallery along the side of the crankcase and connected by drillings to the five main bearings. Thence the oil passes into the crankshaft and so through the hollow journals and crank pins to the big ends. Holes are drilled in the big end bearings and connecting rod caps, from which oil is thrown on to the cylinder walls and pistons.

After passing through the engine, the oil collects in the space formed by the extension of the cylinders into the crankcase, whence it is returned by external pipes to the tank. Here the oil is allowed to settle and cool before being pumped back into the engine. The valve gear is lubricated separately.

LEADING PARTICULARS OF "GIPSY MAJOR"

TYPE : Four-cylinder, inverted, air-cooled, direct drive.

ROTATION : Left-hand tractor.

BORE : 118 mm.

STROKE : 140 mm.

CAPACITY : 6,124 c.c.

NORMAL B.H.P. : 120 at 2,100 r.p.m.

MAXIMUM B.H.P. : 130 at 2,350 r.p.m.

COMPRESSION RATIO : 5·25 to 1.

WEIGHT COMPLETE WITH AIRSCREW BOSS, ETC. : 305 lbs. ± 5 lbs.

PETROL CONSUMPTION UNDER CRUISING CONDITIONS : ·57 pints per b.h.p. per hour.

PETROL CONSUMPTION PER HOUR : 9/10 throttle at 2,100 r.p.m., 8·5 gallons (approximately).

PETROL CONSUMPTION PER HOUR : At full throttle at 2,350 r.p.m., 9·75 gallons.

CRUISING REVOLUTIONS PER MINUTE : 1,900–2,050.

OIL CONSUMPTION : 1·75 pints per hour (approximately at normal r.p.m.).

OIL PRESSURE : 40–45 lbs. per sq. in. (35 lbs. per sq. in. minimum).

OIL IN CIRCULATION : 8 pints (minimum).

CARBURETTER : Claudel Hobson A.I. 48.

HEAD OF FUEL REQUIRED : ½ lb. to 1½ lbs. per sq. in.

MAGNETOS : Port—B.T.H. A.G. 4–4, anti-clockwise.
Starboard—(with impulse starter fitted) B.T.H. A.G. 4–4, clockwise.

SPARKING PLUGS : K.L.G. V.12 or Lodge A.55/3.

FUEL PUMPS : When fuel pumps are required dual D.H.A.C. fuel pumps are fitted. (Some early engines were fitted with A.C. Sphinx pumps specially adapted for Gipsy engines.)

FUEL : Good grade automobile fuel with minimum octane value 70 obtained by the C.F.R. motor method (modified to 260° F. mixture temperature) without the use of tetra-ethyl-lead.

OIL : Oil to D.T.D. specification 109. In addition to the above a large range of proprietary brands are approved on which authoritative information can be obtained from the engine manufacturers.

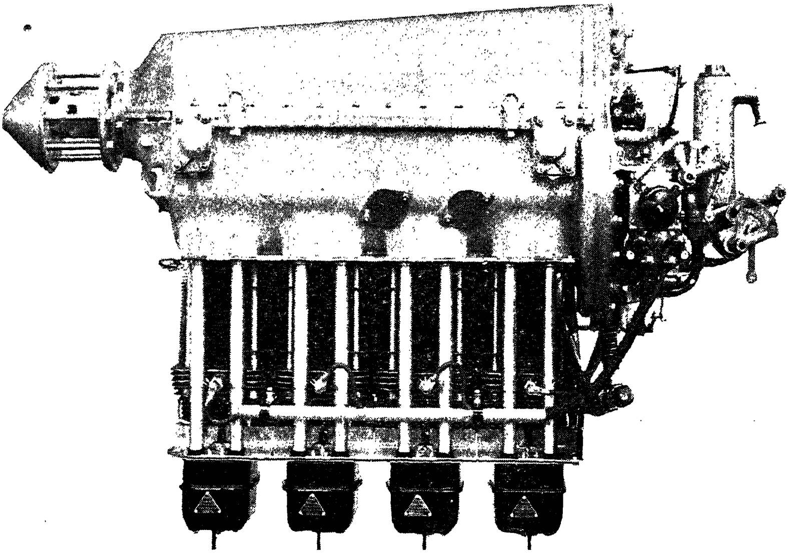


Fig. 1.—THE "GIPSY MAJOR" ENGINE, PORT VIEW.

Constructional details will be given in a later section.

Recent Modifications

The above describes the oil system in principle. The system is shown on the diagram (pp. 8 and 9), and applies in detail to the earlier engines, large numbers of which are in continual operation. The modifications in later engines are as follows :—

(1) The feed to the main bearings is shown on the diagram as an external oil gallery, whereas on later engines it is cast integral with the top cover.

(2) The feed for the timing gear oil jet is shown connected to the oil gallery, whereas it is now supplied direct from pressure filter.

(3) The connection for the oil pressure gauge is shown on the oil gallery, whereas it is now on the pressure filter.

(4) The fitment of the "Auto-Klean Lubricating Oil Filter" has superseded the gauze or "Tecalemit" filter.

These are the essential differences in the system and will be immediately recognised by the engineer when examining a particular engine.

In addition to the standard gravity oil return system as described, alternative scavenger pump return systems can be fitted to the designers' requirements. This is done when the installation will not allow the oil tank to be arranged sufficiently low for the gravity oil system to function correctly. Three systems are available as follows :—

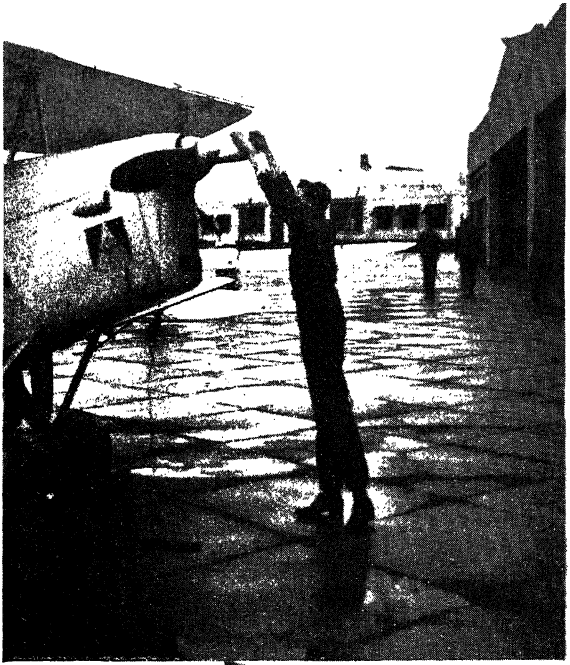


Fig. 2.—AIRSCREW SWINGING.

Before starting up it is essential to check over the points enumerated on pages 11, 12 and 13. In particular the setting of the airscrew in relation to the compressions is very important (see Fig. 14).

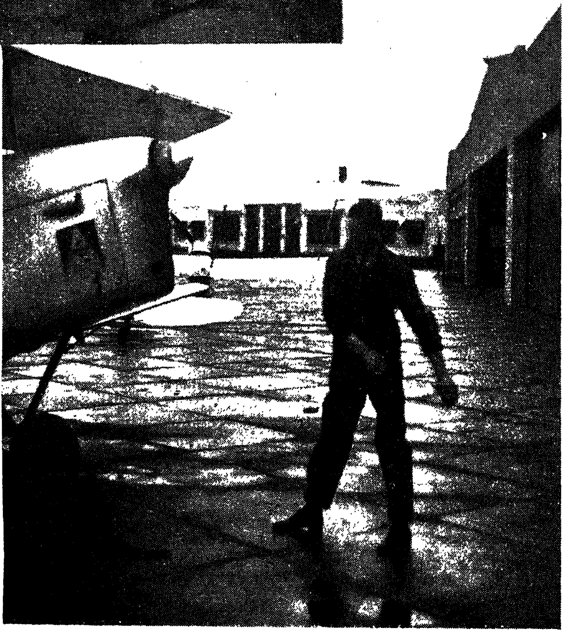


Fig. 3.—AIRSCREW SWINGING.

When starting from cold, open throttle slightly, put switches in "on" position, swing airscrew straight away, and engine generally starts after being pulled over about four compressions. Special directions for starting with engine hot will be found on p. 13.

Oil Scavenge System

(*a*) In the first system, the front and rear of the crankcase drain by gravity into the cast settling reservoir attached to the bottom of the rear cover in place of the normal gravity drain connection; the oil in the settling reservoir is then returned to the oil tank on the aeroplane by the suction pump.

(*b*) In the second system, the front crankcase drain is scavenged by means of a suction pump, from where it is returned back to the tank in the aeroplane. Oil collected at the rear of the crankcase drains to a cast settling reservoir attached to the bottom of the rear cover in place of the normal gravity drain connection, from where it is returned by the second suction pump, back to the oil tank in the aeroplane.

(*c*) In the third system, the front crankcase drain is scavenged by the suction pump and the rear crankcase is drained by gravity as in the standard system.

System (*a*) is fitted to Leopard Moths and Hornet Moths.

System (*b*) is fitted to Dragonfly aeroplanes.

System (*c*) is fitted to special Tiger Moths.

These systems are, of course, available to designers of other types of aeroplanes.

Maintenance of Oil Scavenge Systems

The filter contained in each of these systems should be cleaned after every 25 hours' flying in accordance with the maintenance schedule.

The complete procedure to be followed in the routine maintenance schedules will be described and illustrated in detail in later sections.

Oil Supply for Extended Inverted Flight

As the normal engine can only be run in the inverted position for short periods owing to failure of the oil supply, an oil system which allows the engine to be run inverted for periods up to 15 minutes is available. This consists of an additional pump situated on the timing gear cover. The existing pump and connections are unaltered except that the supply from the additional pump is connected to the pipe leading from the standard pump to the pressure oil filter. The suction side of the additional pump is led to a connection at the top of the timing gear cover. When the engine is running inverted the normal oil supply fails and the additional pump circulates the small amount of oil in the engine through the normal oil systems, so enabling inverted flying to be indulged in up to the period mentioned, for which period this amount of oil is considered sufficient.

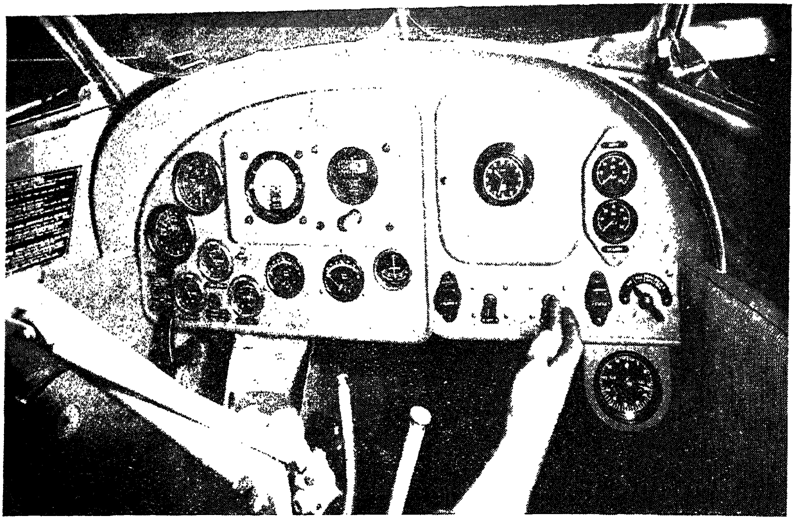


Fig. 4.—VIEW OF INSTRUMENT BOARD OF "DRAGONFLY."

Before starting up, check that the fuel tank contains sufficient for the flight intended.

RUNNING INSTRUCTIONS

Cruising Speed and Engine Revolutions

To state exactly the most suitable cruising speed and engine revolutions for any aeroplane is difficult for the following reasons :—

(*a*) Airscrews may have very slight and unavoidable differences due to manufacture or climatic conditions which cause the revolutions to vary above or below standard.

(*b*) Flying at varying altitudes affects revolutions and also air speed readings.

(*c*) Large variations of temperature affect revolutions and air speed.

High altitude is the factor causing the greatest variation to air speed reading, and it can be taken that for every 1,000 ft. 1·5 m.p.h. should be added to the air speed reading to give true air speed. In high temperature at any altitude 2 m.p.h. should be added to the reading.

For the above reasons the cruising r.p.m. are given within fairly wide limits, and it is naturally to the interest of the pilot to keep well within the higher figure of the cruising revolutions, except in unusual circumstances, such as flying against a strong head-wind.

[An Air Ministry regulation requires "full normal" revolutions to be given on instrument board, but this figure has no real bearing on the matter of cruising revolutions or air speed.]

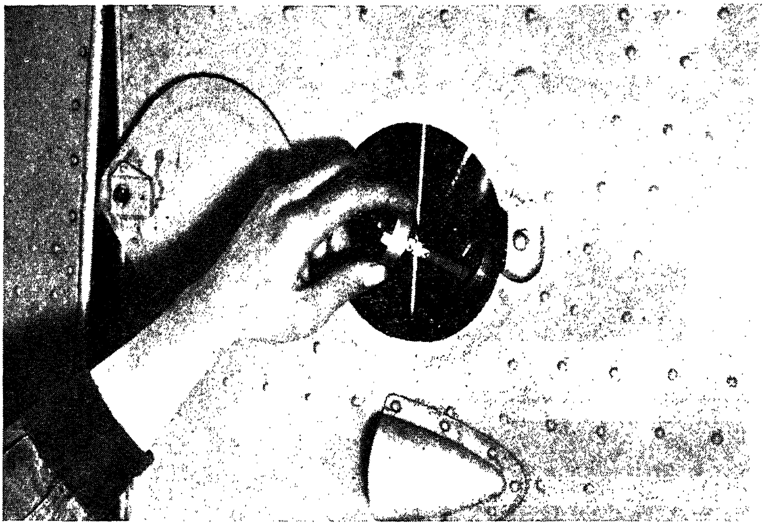


Fig. 5.—BEFORE STARTING ENGINE FOR THE FIRST TIME.
Check that there is sufficient oil in the tank.

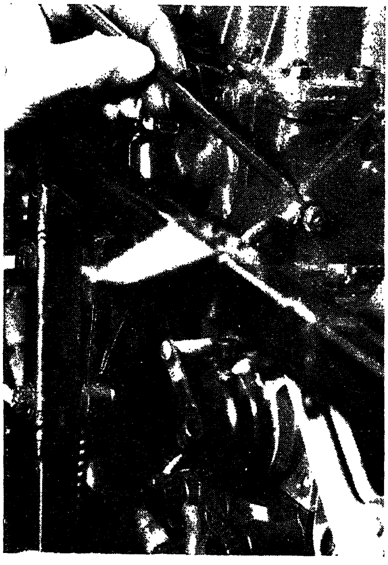


Fig. 6.—BEFORE STARTING ENGINE FOR THE FIRST TIME.

See that the magneto earthing wires are connected up correctly.

Fig. 7.—BEFORE STARTING ENGINE FOR THE FIRST TIME.

Test the engine controls. An assistant is in the cockpit working [illegible]ever,

LUBRICATION SYSTEM "GIPSY MAJOR" ENGINE

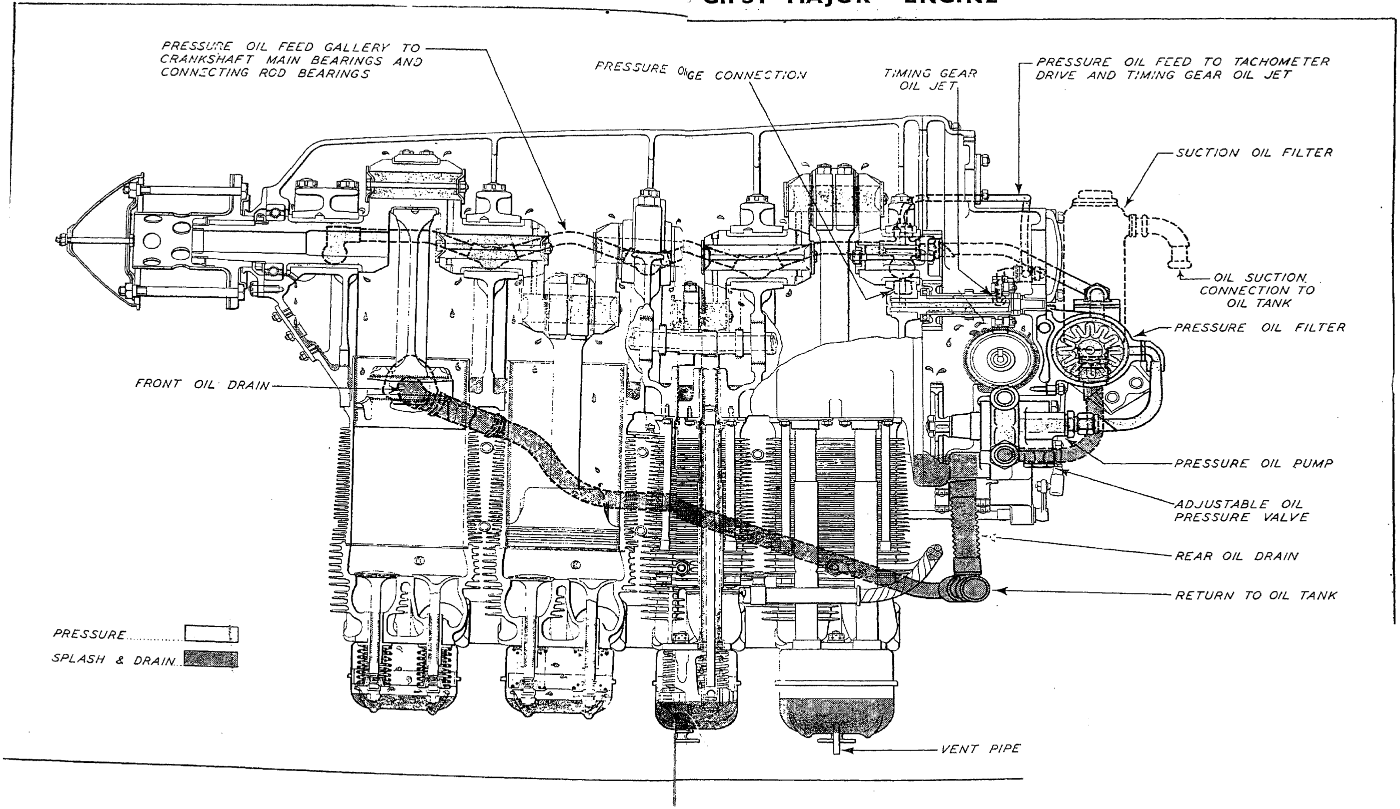

PRESSURE OIL FEED GALLERY TO CRANKSHAFT MAIN BEARINGS AND CONNECTING ROD BEARINGS
PRESSURE GAUGE CONNECTION
TIMING GEAR OIL JET
PRESSURE OIL FEED TO TACHOMETER DRIVE AND TIMING GEAR OIL JET
SUCTION OIL FILTER
OIL SUCTION CONNECTION TO OIL TANK
PRESSURE OIL FILTER
FRONT OIL DRAIN
PRESSURE OIL PUMP
ADJUSTABLE OIL PRESSURE VALVE
REAR OIL DRAIN
RETURN TO OIL TANK
PRESSURE
SPLASH & DRAIN
VENT PIPE

Fig. 8.—BEFORE STARTING ENGINE.

See that connection between oil pressure gauge and pipe is correct.

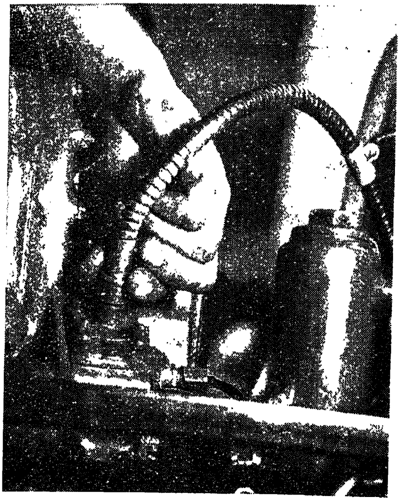


Fig. 9.—BEFORE STARTING ENGINE.

Check tachometer drive connection at engine.

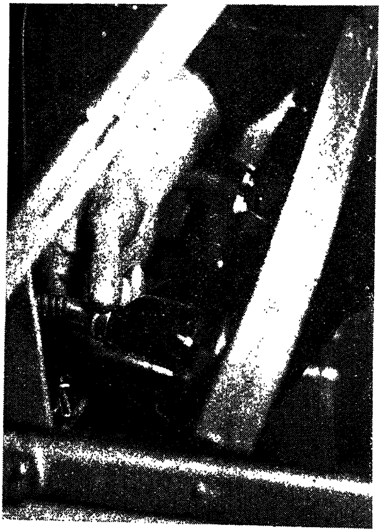


Fig. 10—BEFORE STARTING ENGINE.

Check that the [tachometer drive connection is correct at dashboard.

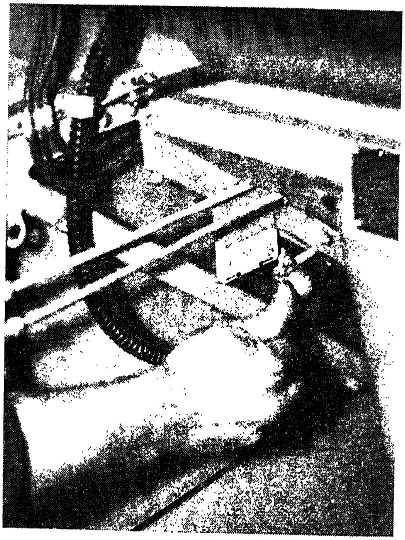


Fig. 11.—BEFORE STARTING ENGINE.

Turn on the petrol and check for leaks and flow. See also Fig. 12.

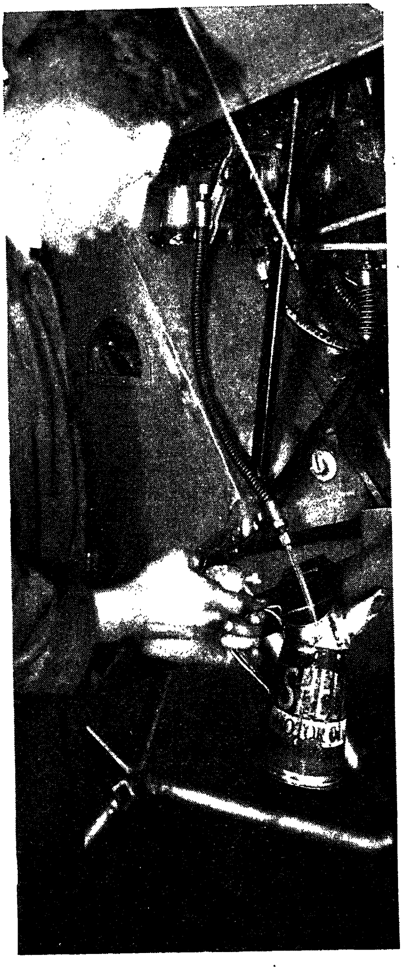


Fig. 12.—BEFORE STARTING ENGINE.

Turn on petrol and check for leaks and flow.

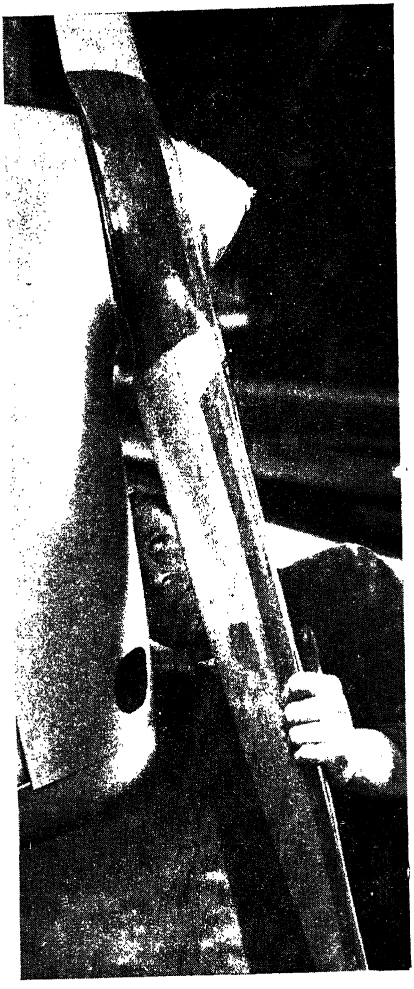


Fig. 13.—BEFORE STARTING ENGINE.

Turn airscrew and check clearance between spinner and cowling.

Points to Check before Starting Up

Before starting the engine *for the first time* it is as well to check up the following points :—

1. See that sufficient fuel is in the tank. Any good grade automobile fuel can be used. It is not necessary to use a petrol benzole mixture, though slightly more power will be obtained should this be used.

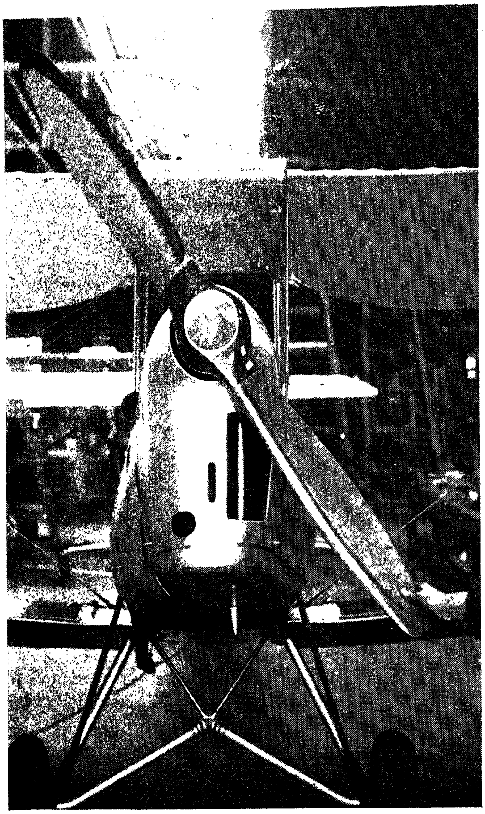


Fig. 14.—BEFORE STARTING ENGINE.

See that setting of airscrew in relation to compressions gives a good swinging position. This will vary slightly with different types of aeroplanes, but on most normal aeroplanes it will be correct if the "click" given by the impulse starter occurs when the airscrew is in the position shown in the photograph.

2. See that sufficient oil is in the tank.
3. See that the magneto earthing wires are connected up correctly. This should be checked by the use of an electric torch or hand lamp, connected up to the earthing spring of the contact breaker cover after removal of this part from the magneto. This will show which switch is connected to the magneto contact breaker under test, also that the switch is earthing properly. The ignition switch should be left in the "OFF" position and engine should not be turned with the contact breaker covers out of place.
4. Check over tightness and locking of all bolts, nuts, etc., on engine and mounting.
5. Operate all engine controls to see that these work freely and give full movement of throttle, etc.

6. Check connections of oil pressure gauge and pipe.
7. Check connections of tachometer drive.
8. Check all cowling and fixings and locking of draw wires, etc.
9. Turn on petrol and check for leaks and flow. If pumps are fitted, check operation of priming pump.
10. Turn airscrew and check clearance between spinner and cowling.
11. See that setting of airscrew in relation to compressions gives a good swinging position. This will be correct on most normal aeroplanes if the audible click given by the impulse starter takes place when the airscrew blade is between 30–45 degrees from the lower vertical position.
12. Check operation of hand starter.
13. Check oil level in valve gear covers and fill up if necessary to level indicated on instruction plate riveted to cover.

Starting by Airscrew Swinging—Gravity System

Flood carburetter by depressing tickler provided in top section of float chamber of carburetter.

Pump System

A.C. Sphinx pumps: depress tickler and use doping pump until carburetter floods. If a doping pump is not fitted the airscrew will have to be turned over by hand or starter with tickler depressed until carburetter floods.

D.H.A.C. Pumps

Operate priming levers on pumps with tickler depressed until carburetter floods.

Care must be taken when flooding carburetter not to overdo this, as the carburetter floods directly into the induction pipe. The best way is to listen at the air intake when flooding carburetter, and when the petrol is heard coming through to release tickler. If the tickler is held down until carburetter floods sufficiently for petrol to be seen draining from the induction pipe, starting will be difficult as the mixture will be too rich.

Open throttle slightly, put switches in " ON " position, swing airscrew straight away and the engine generally starts after being pulled over about four compressions.

Starting Engine when Hot

Do not flood carburetter. Open throttle slightly, put switches in " ON " position and swing airscrew. If engine does not start after being pulled over four compressions, put switches " OFF " and turn engine forwards or backwards for five or six compressions, close throttle, put switches in " ON " position and repeat as first part of this paragraph.

Starting with the Hand Starter

The same instructions as given in previous paragraphs on " Starting by Airscrew Swinging " can be generally applied.

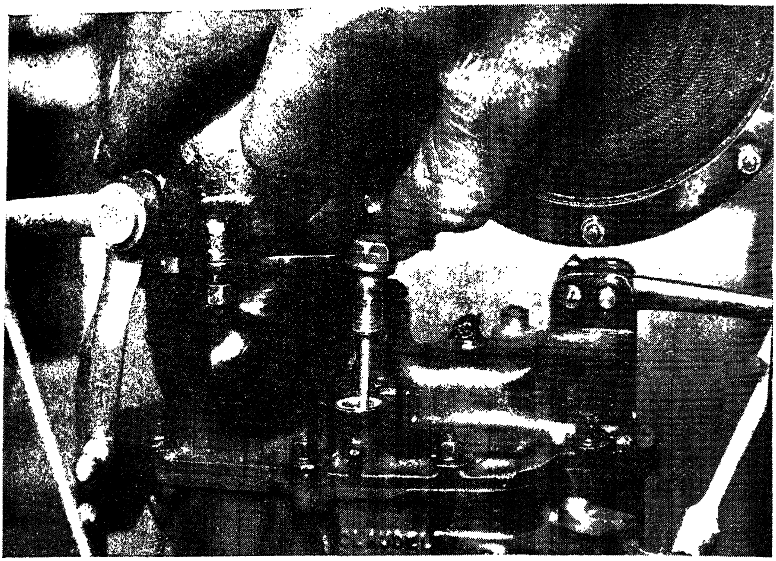


Fig. 15.—CARBURETTER SLOW RUNNING JET CHOKED.

Remove slow running jet holder from carburetter as shown in the photograph above.

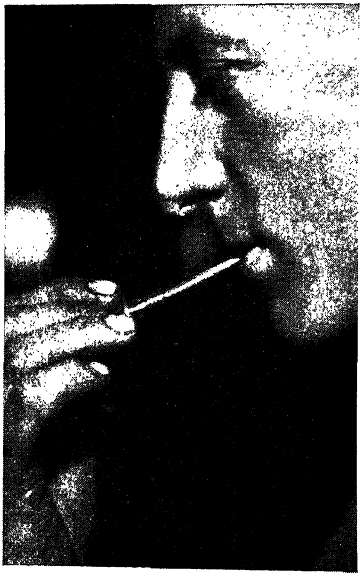


Fig. 16.—CLEARING THE SLOW RUNNING JET.

This can be cleared by blowing through it from the lower end.

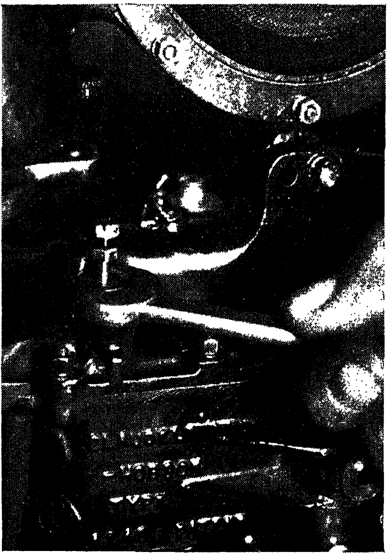


Fig. 17.—CLEARING THE SLOW RUNNING JET.

After clearing the jet, replace slow running adjustment screw and replace the jet in position as shown.

POSSIBLE CAUSES OF FAILURE TO START

Carburetter Slow Running Jet Choked

This can be cleared by following directions given below. Remove slow running jet holder from carburetter. This holder has a hexagon head and screws down on top cover of float chamber. The slow running jet, which is a restriction in the small tube screwed in the lower end of holder, can be cleared by blowing through it. If the slow running adjustment screw is removed from top of holder there will be no need to remove slow running jet from holder to see whether jet is clear.

Water in Carburetter

Remove main and power jets and flush carburetter through by turning petrol tap "ON."

Impulse Starter not Working Properly

When the airscrew is turned over slowly, there should be an audible click from the impulse mechanism on the starboard magneto. The most frequent cause of trouble with this part is that the toggle mechanism gets stuck up with oil. This can be cured by squirting out with paraffin and re-oiling with thin oil. Should this not affect a cure, magneto should be removed and impulse starter dismantled to find cause of failure.

Contact Breaker Rocker Stuck

This is generally caused by swelling of the bush owing to damp atmosphere. In this case the rocker should be removed, after disconnecting return spring, and bush should be eased down carefully with a fine grade of emery cloth. Oil very lightly on replacement with sewing machine or other similar type of thin oil.

If the engine has been standing in a damp atmosphere it may be necessary to wipe the insulators of the sparking plugs and the distributors of the magnetos before a start can be made, owing to the surface leakage of electricity which takes place under these conditions.

When Engine has Started

If oil pressure does not show between 30 and 40 lbs. per sq. in. within one minute, shut engine down and investigate cause. Possible causes are: stuck release valve, air leaks in oil suction pipe, pump requires priming, defective oil pressure gauge or choked pipe to gauge. When oil pressure is at figures given run engine at 800–900 r.p.m. for at least four minutes to allow the oil to warm up and circulate freely.

The oil temperature will probably not show on the thermometer, but it may be assumed that, after four minutes running at the above r.p.m., the oil temperature and circulation is satisfactory, and the engine can be opened up to full throttle to ascertain the ground r.p.m.

Fig. 18.—WATER IN CARBURETTER.

To clear this fault, first remove the main jet.

Fig. 19.—WATER IN CARBURETTER.

Next, remove the power jet.

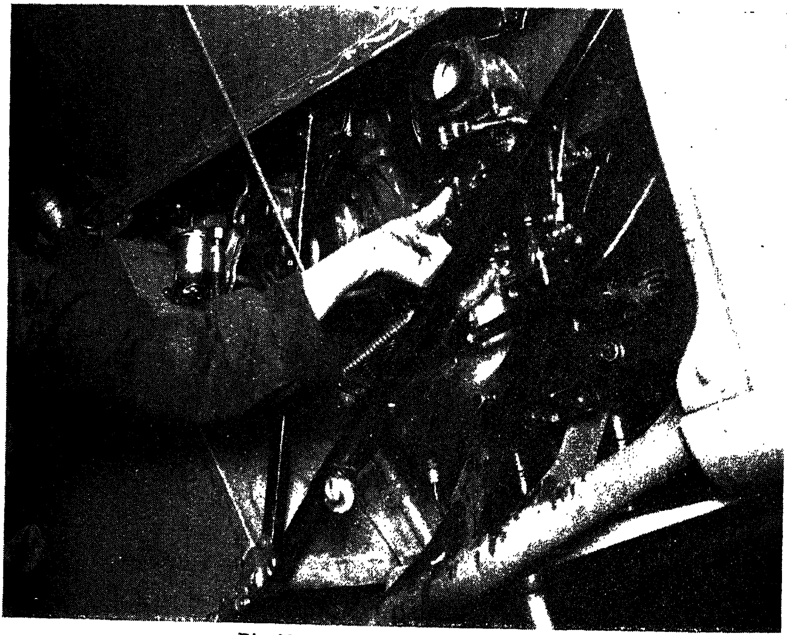


Fig. 20.—WATER IN CARBURETTER.

After the main jet and the power jet have been removed, the carburetter should be flushed with petrol by turning the petrol tap on whilst the jets are removed. When the water has been dislodged, the jets are re-assembled.

The opening up of the engine to full throttle on the ground must be carried out with a certain amount of discretion, and under no circumstances should the full throttle running exceed a period of 30 seconds. It should be observed that this full throttle running is only for the purpose of obtaining the ground r.p.m. of the engine and not for the purpose of warming up.

R.p.m. on the ground will vary with different airscrews fitted, but should be between 1,900–2,050.

The running of the engine should be checked on each magneto. R.p.m. will probably drop slightly, but engine should run smoothly and evenly on each magneto. Check magnetos with engines running between 1,600 r.p.m. and full throttle. Oil pressure under these conditions should be between 40 and 45 lbs. per sq. in.

POSSIBLE TROUBLES

Should any One Cylinder Miss-fire or Cut Out when Running on One Magneto

locate cylinder and clean sparking plug or fit new one. Should this not effect a cure, examine high tension lead for defective insulation, internal breakages of wire or faulty end connections and renew if necessary.

Should Engine Miss-fire on One Magneto

check and test all plugs and magneto. If trouble is located to magneto, and no fault can be found which can be readily rectified, fit new magneto. If engine cuts right out on one magneto, suspect switches and low tension wires as well as magneto, also see that high tension wires are connected up to their correct position on magneto distributor.

Carburetter Floods

Possible causes are: dirt under needle, worn needle seating and needle, or stickiness of float arm or needle. For a worn needle seating a cure can sometimes be effected by lightly lapping needle in seating with metal polish or some very fine abrasive.

If Engine Runs Slowly but will not Open Up

Possible causes are: water in carburetter, main or power jets choked, air lock in petrol pipes, or choked filter.

Mixture Correction

This can best be carried out by judicious use of the mixture control. This can be used at any altitude when the machine is cruising, but should not be used at full throttle below 5,000 ft. Under no conditions should the weakening of the mixture cause a drop in r.p.m.

Engine Cutting Out while in Flight

Make sure the switches have not been switched off accidentally. It is also worth while trying the engine on separate magnetos as a fault in one magneto may upset running of engine.

ROUGH RUNNING—SOME POSSIBLE CAUSES

Airscrew Out of Balance

If possible have airscrew rebalanced. When airscrew is refitted to engine it should be a snug fit on spigot of boss, and bolts should be tightened up evenly. Track of blades measured at tips should not differ by more than $\frac{1}{8}$ in. or 3·5 mm.

Tappets Out of Adjustment

Reset to standard clearance.

Sparking Plugs Dirty or Wrongly Adjusted

Clean, reset gaps and test, if possible, under pressure.

Magneto Contact Breakers Dirty or Incorrectly Adjusted

Clean and re-adjust.

Engine Mounting or Holding Down Bolts Loose

If trunnion type of mounting, rubber blocks may be incorrectly fitted.

Compressions Uneven

If compression on any cylinder is very weak, remove head and cylinder and investigate cause. Probable causes are: stuck piston rings, leaky valves, or defective head joint washer.

Air Leaks in Induction System

Inspect and test induction manifold for leaks both external and into heater jacket. Check cylinder and carburetter joint washers for condition.

Low r.p.m. on Ground

If all parts of the engine are in order and engine is running well, an unsuitable airscrew will pull engine r.p.m. down. Another airscrew should be tried to check this.

Low Oil Pressure

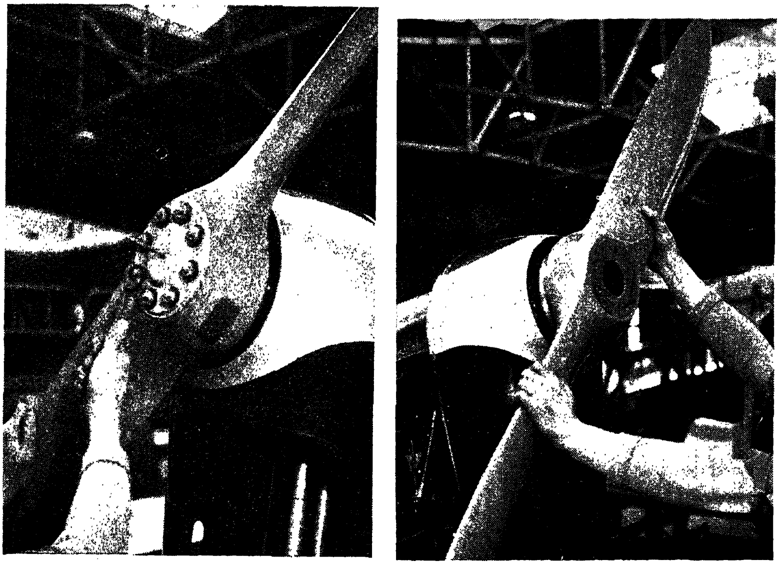
This may be due to any of the following causes. Insufficient oil in tank, air leaks in suction pipes, suction or oil pressure filter choked, stuck release valve, choked pressure gauge pipe or defective pressure gauge.

Cold Weather Difficulties

Under extremely cold operating conditions the makers are prepared to approve thinner grades of oil and advice can be obtained on this point if required. Under arctic conditions it might even be necessary to pre-heat the oil.

"GIPSY MAJOR" AERO ENGINE

SECTION II—COMPLETE OVERHAUL



g. 1.—THE FIRST STEP IN REMOVING THE ENGINE FROM AIRFRAME FOR COMPLETE OVERHAUL IS TO TAKE OFF THE AIRSCREW.

Removing Engine from Airframe

1. Proceed in the following order. Remove airscrew, cowling and carburetter air intake; disconnect oil and fuel pipes, engine controls, exhaust pipe, tachometer drive and breather pipe. Remove bolts or caps which hold engine feet. Engine should be slung by eyebolts in crankcase. Lifting cables should be kept clear of all parts which can be damaged when load is applied to cables.

2. With engine still on slings, remove engine feet and fit type of feet suitable for stand and test equipment.

3. Attach engine to stand. The reversible type of stand is the most suitable, as this enables engine to be turned over for removal of heads, cylinders, etc.

Removing Crankshaft Nut and Airscrew Boss

4. Remove airscrew sleeve from boss. Bend back tab of crankshaft nut lock washer. Slip airscrew on bolts of airscrew boss. Insert box spanner in centre hole in airscrew, and engage spanner with crankshaft

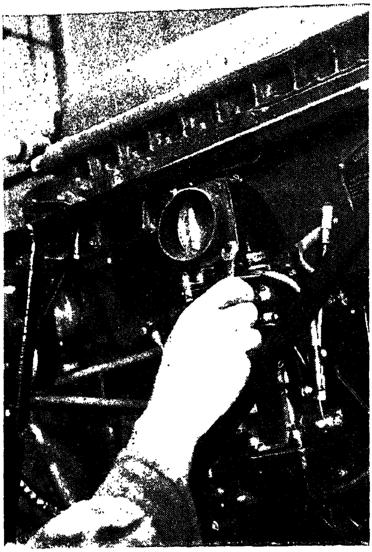
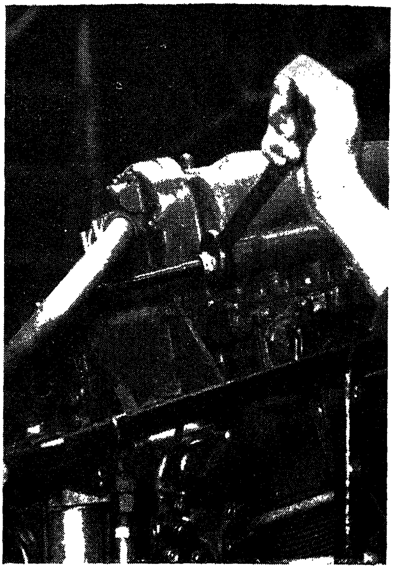


Fig. 2.—TO REMOVE THE ENGINE FROM AIRFRAME (2).

After removing the cowling, detach the carburetter air intake.



3.—TO REMOVE THE ENGINE FROM AIRFRAME (3).

Disconnect the oil pipe.

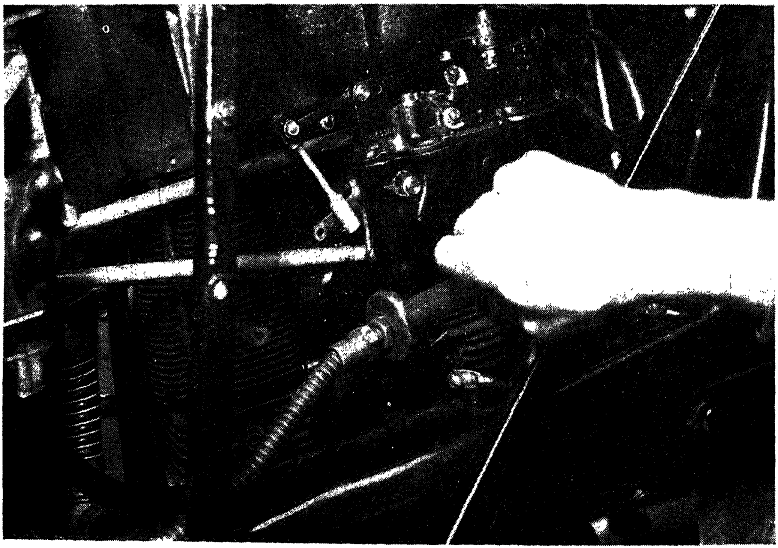


Fig. 4.—TO REMOVE THE ENGINE FROM AIRFRAME (4).

Disconnect the fuel pipe.

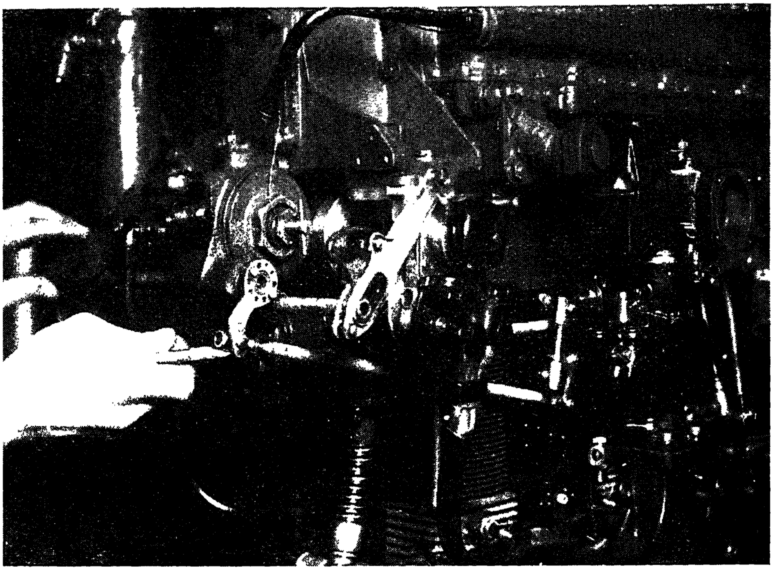


Fig. 5.—To remove the engine from airframe (5).
The next step is to disconnect the engine controls, followed by the exhaust pipe.

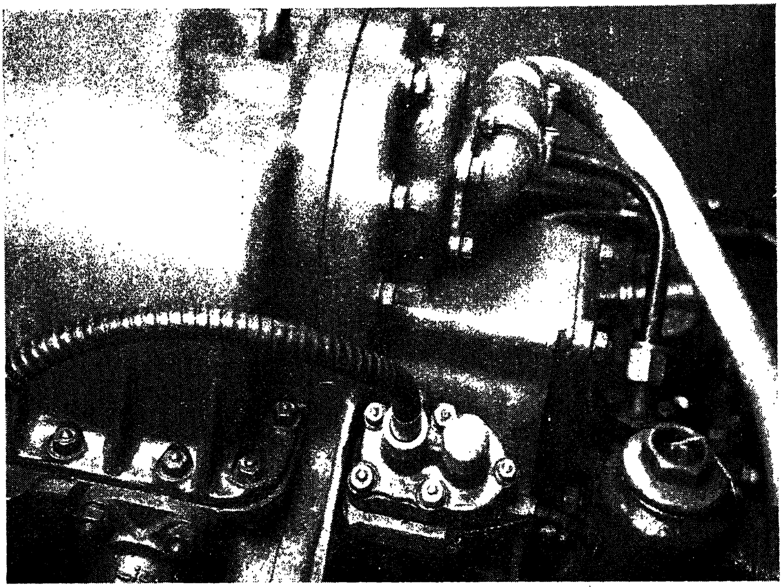


Fig. 6.—To remove the engine from airframe (6).
After the exhaust pipe, disconnect the tachometer drive and breather pipe, shown above.

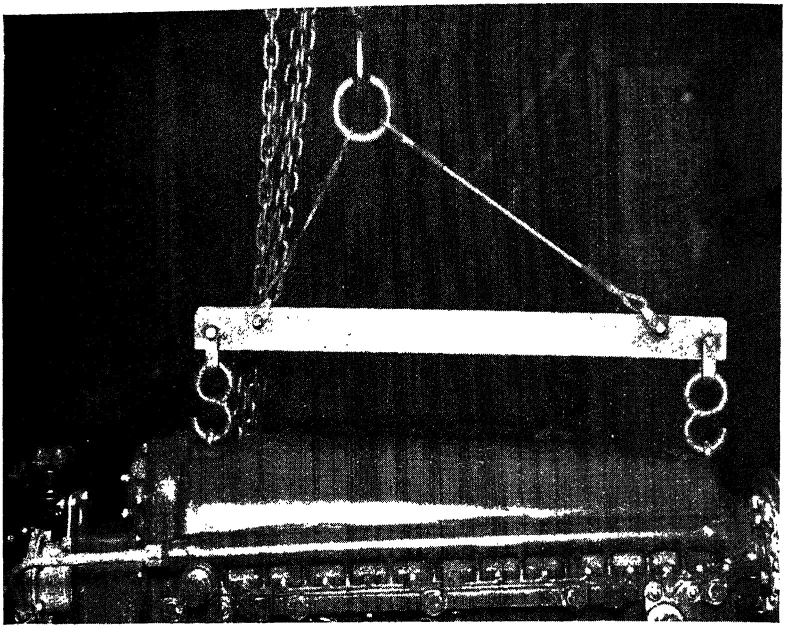


Fig. 7.—To REMOVE THE ENGINE FROM AIRFRAME (8).

After all necessary disconnections have been made as shown in the previous illustrations, the engine should be slung by eyebolts in crankcase. Lifting gear should be kept clear of all parts which can be damaged when load is applied to the cables. The above shows a useful type of wire sling.

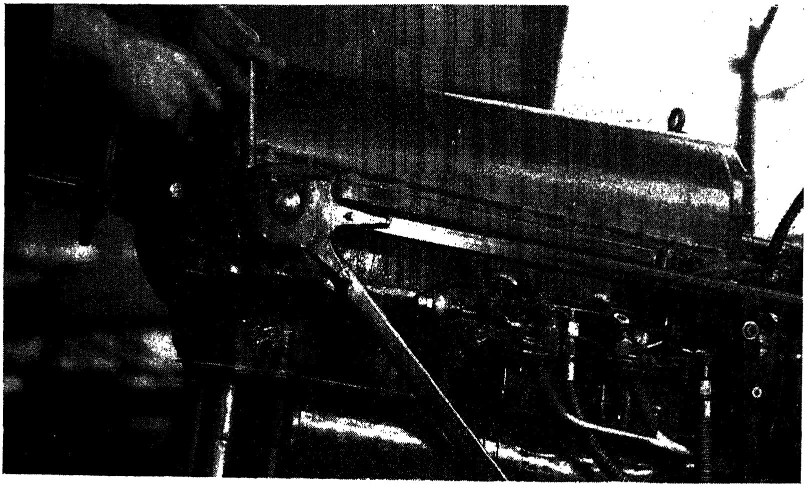


Fig. 8.—To REMOVE THE ENGINE FROM AIRFRAME (7).

Removing engine holding down bolts.

nut. Insert tommy bar in box spanner and unscrew crankshaft nut, using airscrew to stop crankshaft turning while unscrewing nut.

5. After removal of airscrew, screw extractor as far on threads of airscrew boss as possible. The box spanner can be used to screw this on. Insert tommy bar in screw on puller and turn this screw up until tight against end of crankshaft. If after applying to the tommy bar, the boss will not move on crankshaft, tap end of screw with hammer, at the same time applying pressure to tommy bar. This will cause the boss to break loose from taper.

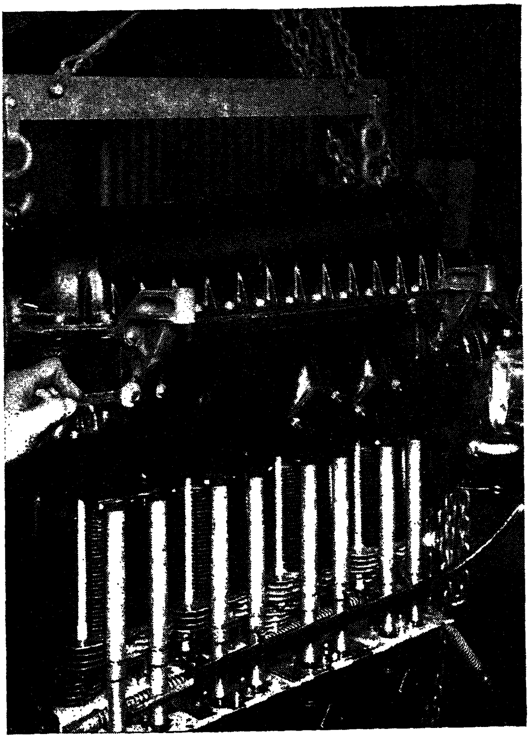


Fig. 9.—To REMOVE THE ENGINE FROM AIRFRAME (9).

With the engine still on slings, remove the engine feet and fit type of feet suitable for stand and test equipment.

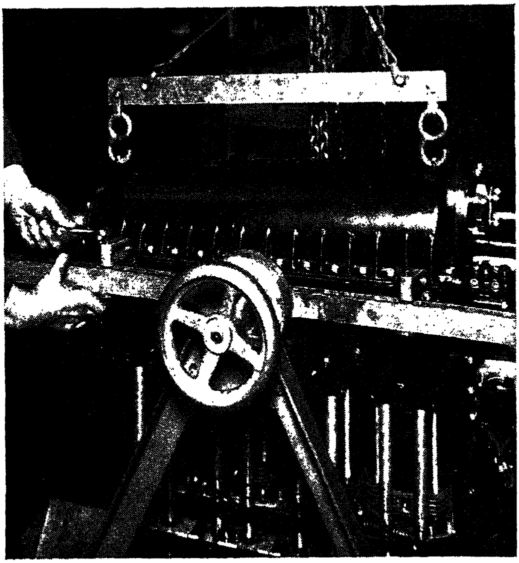


Fig. 10 (*below*).—To REMOVE THE ENGINE FROM THE AIRFRAME—FINAL OPERATION.

Secure the engine to the stand.

Dismantling the Engine

6. Remove engine controls.

7. Remove remainder of cowling.

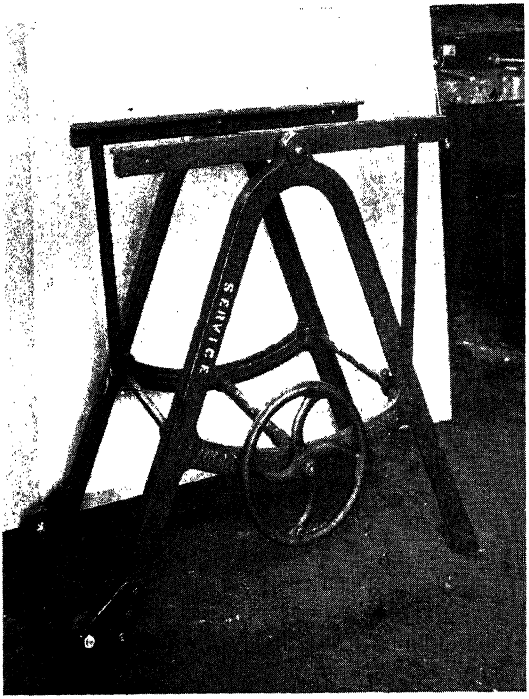


Fig. 11.—THE MOST SUITABLE TYPE OF STAND IS THE REVERSIBLE—SHOWN ABOVE.

This type of stand enables the engine to be turned over for removal of heads, cylinders, etc.

8. Remove carburetter heat pipe using spanner for union nuts.

9. Remove small nuts which hold exhaust manifold to cylinder head flanges, using universal spanner. Manifold can then be dropped off studs and slid out of sleeve on exhaust pipe.

10. Unscrew fuel pipe union on carburetter.

11. Take out taper pins in locating collars on throttle and mixture control torsion shafts and slide torsion shaft rearwards clear of carburetter.

12. Remove air intake by undoing the four nuts which hold this to carburetter flange.

13. Remove carburetter from induction pipe by undoing the four nuts which hold carburetter to induction pipe flange.

14. Remove small nuts which hold induction manifold to cylinder head flanges, using spanner. Manifold can then be slid off studs.

15. Remove high tension leads from sparking plugs and unscrew sparking plugs from cylinders, using box spanner and tommy bar.

16. Unscrew knurled studs which hold valve gear covers in place. Remove covers complete with Hornex joint ring.

Removing Cylinder Heads

nuts on ball ends of

as far as possible.

off clamp bolts on valve rocker spindle ; push rocker spindle

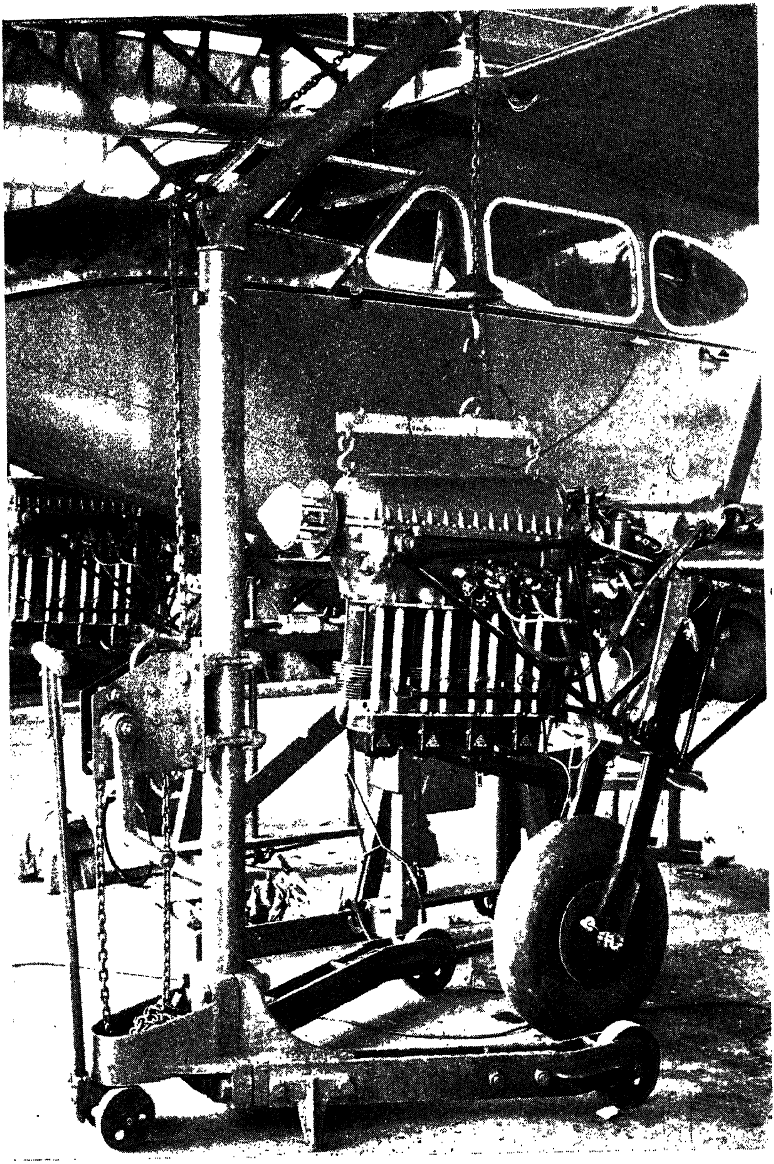


Fig. 11A.—Hoist and sling gear in operation.

and rocker to one side ; push rocker and valve hard up ; tappet rod can then be withdrawn by moving it slightly to one side. Remove all tappet rods in this way.

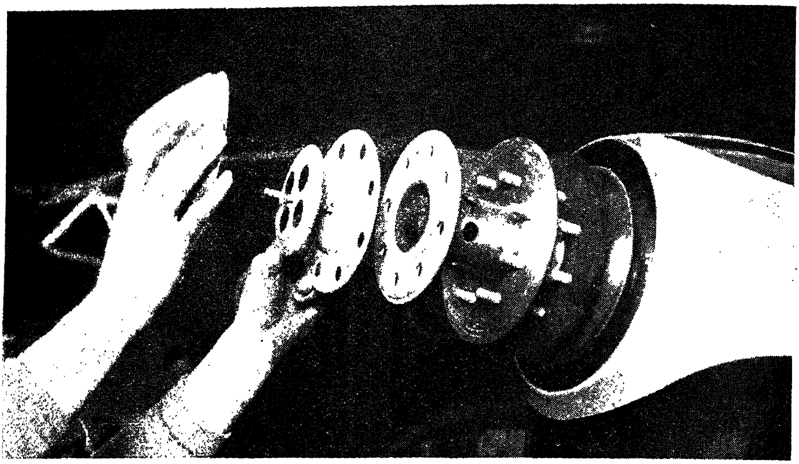


Fig. 12.—AIRSCREW REMOVED.

Showing the airscrew boss. Sleeve of airscrew is just drawn off bolts, and the holding front plate, spinner plate, and spinner are shown in order of assembly.

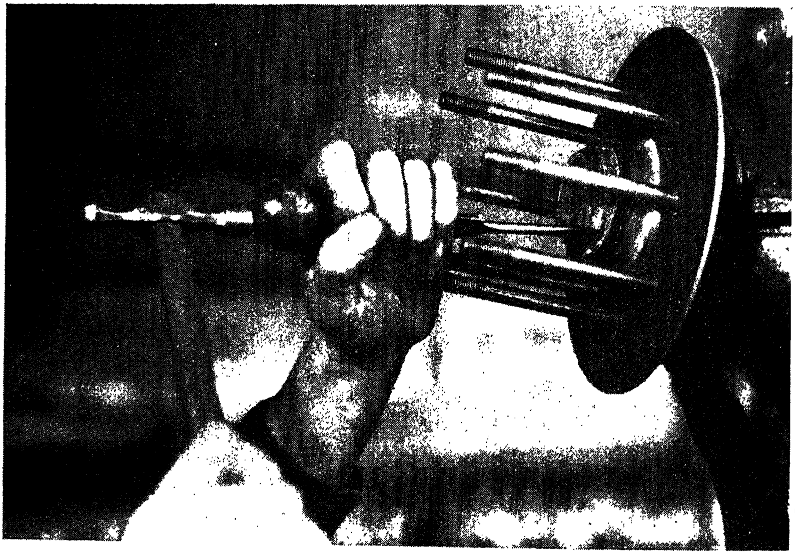


Fig. 13.—UNDOING MAIN CRANKSHAFT NUT (1).

First bend back the top of the crankshaft nut lock washer.

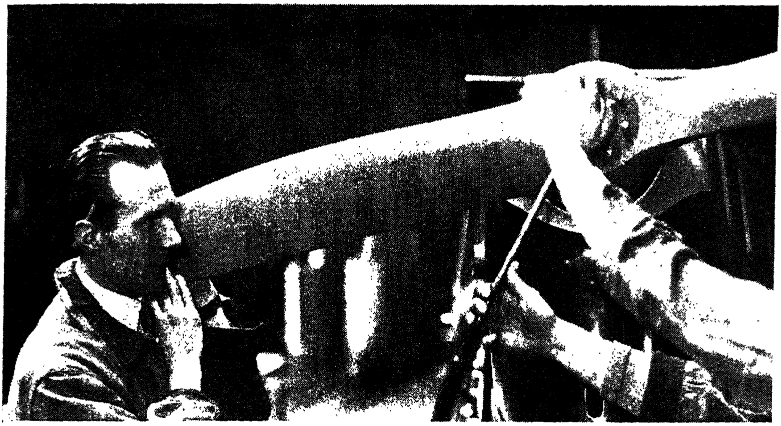


Fig. 14.—UNDOING MAIN CRANKSHAFT NUT (2).

Slip the airscrew on bolts of airscrew boss. Insert box spanner in centre hole in airscrew and engage spanner with crankshaft nut. Insert tommy bar in box spanner and unscrew crankshaft nut, using airscrew to stop crankshaft turning while unscrewing nut.

20. Push bottom part of tappet casing tube up upper part until clear of bottom cup. The tube can then be swung clear of bottom cup and lowered out of upper cup. Remove all tappet casing tubes in this way.

21. Remove small bolts which hold port side high tension wire tubes and, leaving high tension wires still connected to magneto, place high tension tube and wires at rear of engine, so that they are out of the way of any further work being carried out.

22. Loosen all cylinder head nuts, using spanner. Ease cylinder heads down as these are being unscrewed, and remove all nuts, washers

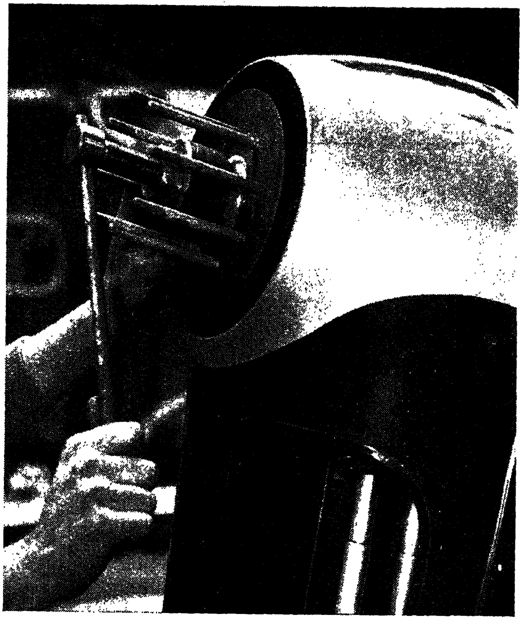


Fig. 15.—NEXT EXTRACT THE AIRSCREW BOSS FROM SHAFT.

This shows the box extractor in position and being used to loosen the boss.

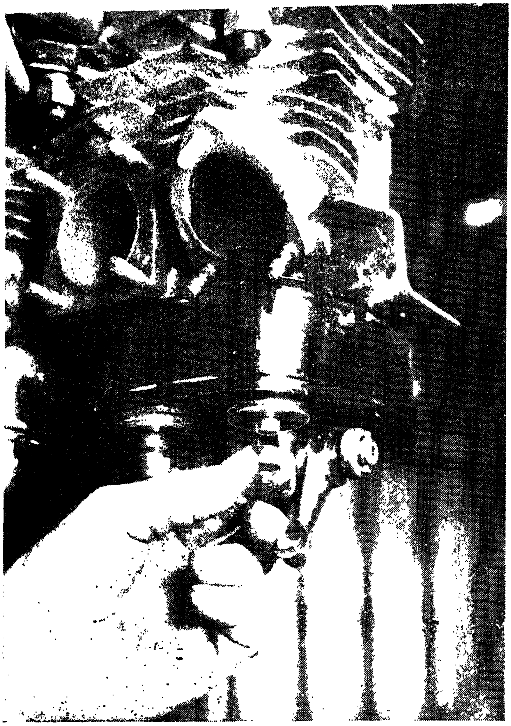


Fig. 16.—REMOVING VALVE THIMBLES.

Raise valve collar slightly. This will lift the valve and allow the thimble to be lifted off.

and bridge plates. Should any of the cylinder heads show signs of sticking to the cylinders, remove cylinder and head together, taking care to steady piston as cylinder is completely removed. When removing heads separately the cylinder should be supported until it is withdrawn from crankcase otherwise it may fall out.

Removing Cylinders and Pistons

23. With pistons at the bottom of stroke, carefully withdraw cylinders from crankcase. When cylinder is low enough steady piston while cylinder is being completely removed.

24. Remove circlip from one end of each gudgeon pin. Insert end of tool in small groove in gudgeon pin and lift circlip out of groove. Insert screwdriver between circlip and gudgeon pin washer. Twist screwdriver which will lever circlip off end of gudgeon pin. Remove any burrs on end of gudgeon pin, push pin out, and lower pistons. If gudgeon pin is too tight to be removed by hand it should be extracted by using gudgeon pin extractor.

25. Cover up cylinder bores in crankcase with rag or paper.

To Dismantle Cylinder Heads

26. Push collars on valve rocker spindle as far as possible inwards, which will allow the small retaining pin in the end of the rocker spindle to be removed. After removal of pins, slide retaining collars, springs, washers, bushes and rockers off rocker spindles. Place cylinder head over a small block of wood, sufficiently thick to allow the valves to be held in place. Depress valve collar, using valve spring compressor. Collets can then be removed from valve stems. Remove compressor and withdraw

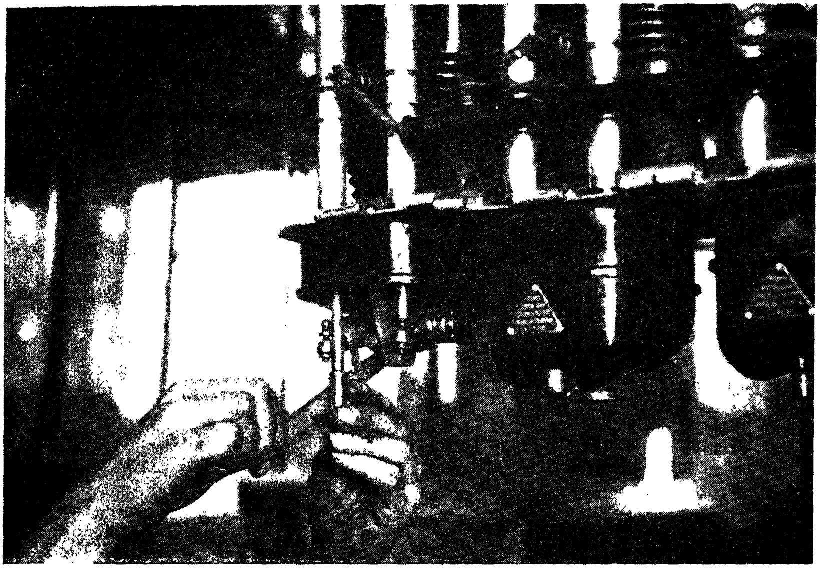


Fig. 17.—METHOD OF REMOVING TAPPET RODS.

Slack off clamp bolts on valve rocker, spindle and push rocker spindle and rocker to one side. By pushing rocker and valve hard up, the tappet rod can then be withdrawn by moving it slightly to one side.

springs and collets. After lifting cylinder head off block valves can be withdrawn.

To Remove Piston Rings from Piston

27. Stand piston on bench with skirt downwards. Insert three narrow strips of thin steel under piston ring and space out equidistantly. Piston rings can then be slid up strips. Commence with top ring and slide all rings upwards.

To Separate Cylinder Head and Cylinder

28. Fix a wooden peg vertically on bench. This peg should be an easy fit in bore of cylinder. Slide cylinder down on peg, which should be long enough to reach inside of head with cylinder clear of bench. If cylinder is brought down smartly, the peg striking inside of head will generally break head loose from cylinder. If head cannot be removed by this means, heat up head in oil and try on peg again while hot.

29. Remove studs fixing magnetos to platform and remove magnetos complete with high tension wires and tubes.

30. Remove gear jet and delivery oil pipes. The small filter in the banjo on end of gear jet pipe should be tied in place in banjo. This filter is easily damaged if allowed to mix with h

31. Remove hand turning gear complete with adaptor.

32. Remove the three 6 mm. nuts which hold the tachometer drive gearbox to the timing gear cover. The gearbox casing should then be tapped with a small mallet to break joint; it can then be withdrawn from the timing gear cover complete with spindle and spiral gear.

33. Remove all the 6 mm. nuts holding timing gear cover to crankcase and sump. Tap timing gear cover all round rear joint face to break joint. Cover can then be withdrawn from studs.

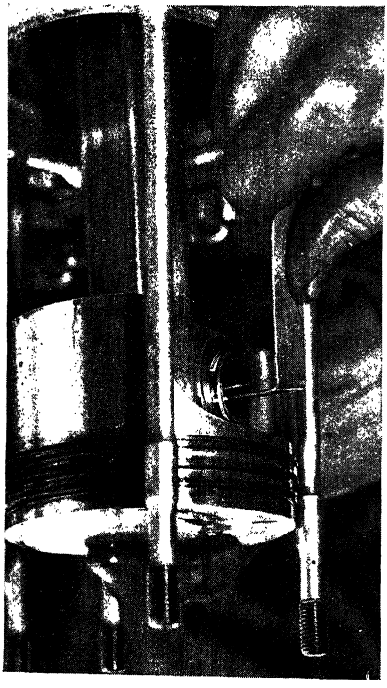


Fig. 19.—REMOVING GUDGEON PIN CIRCLIPS.

This is done by using special tool provided. Insert end of tool in small groove in gudgeon pin and lift circlip out of groove.

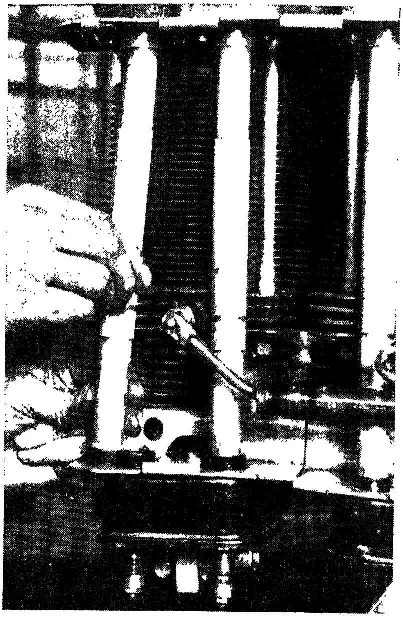


Fig. 18.—HOW TO REMOVE TAPPET ROD CASING TUBES.

Push up bottom part of tappet casing tube and swing it clear of bottom cup.

34. Unscrew slotted nut on rear of idler spindle after removal of split pin. Remove washer, idler gear, thrust race and shims from idler spindle.

35. Remove crankcase front cover after removing split pins and nuts holding this part.

36. Remove all nuts and spring washers holding tappet guides in place.

37. Invert engine.

38. Remove plain nuts and spring washers holding top cover to crankcase. Remove top cover after breaking joint by lightly tapping all round.

39. Remove the split pins and castellated nuts holding main bear-

ing caps. Remove the main bearing caps complete with bearings. Lift crankshaft with connecting rods out of bearings in crankcase and place on crankshaft stand. Remove half bearings from crankcase.

40. Remove split pins and castellated nuts on connecting rod bolts. Lift off caps and half bearings, and lower rods off shaft.

41. Remove split pins and slotted nuts from bolts in crankshaft oil seals. Remove bolts, seals and washers. The two bolts in the main bearing journal oil seals cannot be completely removed, as they are inserted before crankshaft gear is fitted.

42. Remove camshaft gear. Bend back tab out of slot in nut at rear of camshaft. Undo nut, using box spanner. Pull off camshaft gear, using extractor. Remove nuts holding front camshaft bearing. Tap camshaft forward until front camshaft bearing is sufficiently far out of crankcase to be pulled right out. Camshaft should then be pushed back until shoulder is up against the rear camshaft bearing. Camshaft should then be tapped at the front end to bring rear camshaft bearing out. When this is out camshaft should be withdrawn carefully rearwards, so that edges of intermediate camshaft bearings and tappets are not damaged.

43. Remove tappets and guides by tapping out carefully with a soft drift.

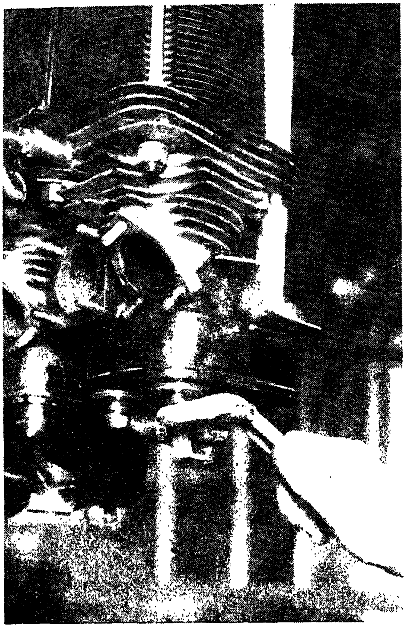


Fig. 20.—METHOD OF DEPRESSING VALVE COLLAR USING VALVE SPRING COMPRESSOR TOOL SUPPLIED.

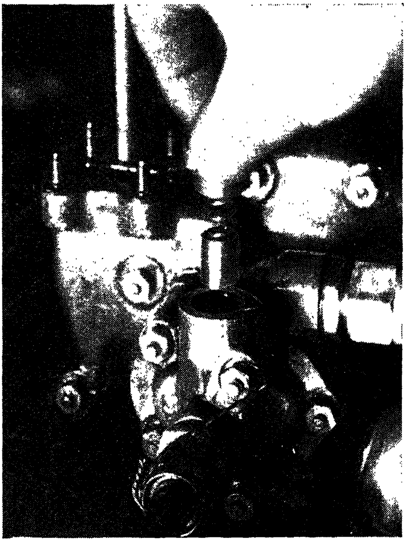


Fig. 21.—REMOVING OIL RELEASE VALVE. After unlocking and unscrewing hexagon plug in oil pump rear cover, release valve and spring can then be withdrawn. Do not lose the shims for release valve adjustment.

DISMANTLING COMPONENTS

Oil Pump

Flatten out tab on tab washer which is under nut holding oil pump driving gear to spindle. Unscrew nut and ease driving gear off spindle. If gear is supported and spindle lightly tapped, the gear should come off spindle without much difficulty. The plain nuts and spring washers which hold pump assembly to timing gear cover should be removed. Pump assembly can then be removed from timing gear cover by sliding out of spigot in timing gear cover and then along studs.

To Remove Release Valve

Straighten tab which locks hexagon plug in oil pump rear cover, unscrew plug and release valve, and spring can then be withdrawn. The shims for release valve adjustment will probably remain in position in piston, but, should they come out, their number should be checked, so that they are all replaced on reassembling.

To Extract the Pump Spindle Bronze Bushes

The following method will work if the bushes are not too tight in place. Fill up bores of bushes with thick grease. Turn a plug to a push fit in bore of bush. If this plug is placed in bore of bush and hammered, the grease will force bush out of place. If this method is not successful, the front and rear covers will have to be mounted in a lathe and the bushes turned out.

Tachometer Drive Attachment, Engine Speed, Single Type

Remove nut and spring washer on countersunk bolt which holds bronze cover to casing. Remove cover. Flatten tab washer under nut which holds spiral gear on spindle. Remove nut and tap spindle through spiral gear and casing.

Tachometer Drive Attachment, Engine Speed, Dual Type

Remove nuts and spring washers from countersunk bolts which hold bronze cover to casing. Remove cover and gear with short shaft. Flatten tab washer under nut which holds spiral gear on spindle. Remove nut and tap spindle through spiral gear and casing.

Tachometer Drive Attachment, Quarter Engine Speed, Dual Type

Remove screwed bearings and slow speed shafts. Remove cap opposite end of high speed shaft. Flatten tab washer under nut which holds spiral gear on spindle. Remove nut and tap spindle through spiral gear and casing.

We shall next describe the dismantling operations for the magneto-driven gear, the crankshaft ball race, crankshaft gear, idler spindle and camshaft front bearings and then proceed to detailed inspection of the components.

"GIPSY MAJOR" AERO ENGINE

SECTION II—COMPLETE OVERHAUL (*continued*)

BEFORE proceeding to carry out a systematic inspection there still remain five more components to be dismantled, namely, the magneto-driven shaft, the crankshaft ball race, the crankshaft gear, the idler spindle and the camshaft front bearings.

Below is given the sequence of operations to be followed in dealing with these. After dismantling is completed a systematic inspection should be carried out in accordance with the schedule beginning on the next page.

Magneto Driven Shaft

Remove split pin and nut from bolt through centre of shaft. Remove bolt and pull out Simms coupling from either side. Remove nuts and spring washers holding oil retainers. Tap hollow shaft on starboard end. This will push port race out of housing and oil retainer off facing and finally shaft will be driven clear of magneto-driven gear, which can then be taken out of recess in timing gear cover. Starboard side ball race can then be driven out of housing which will push oil retainer off facing. Port and starboard housing, if tapped from inside, will come out of bores in timing gear cover.

Crankshaft Ball Race

Flatten tab washer out of slot in ball race securing nut. Unscrew nut, using ring spanner. Remove tab washer. To pull ball race off shaft, use puller. To use this puller proceed as follows :—Place split ring behind ball race and solid ring outside outer race of ball race in front of split ring. Enter special studs through solid ring and screw into split ring. Screw these studs up until hexagon nips ring solid. Enter puller plate on studs and screw nuts on studs until nuts are flush with top of stud. Upon screwing up centre screw, ball race will come off shaft.

Crankshaft Gear

Remove split pin and nut on retaining bolt. Remove retaining bolt. To extract gear, use puller. Place sleeve of extractor over gear so that the flat end rests against rear side of rear crankshaft web. Place pad in recess in front of crankshaft gear. Enter bolt through sleeve, gear, pad and nut. Upon screwing bolt into nut, gear will come out of shaft. To hold nut a short spanner is provided.

Idler Spindle

Flatten tab on copper washer. Undo setscrew in front of idler spindle. Remove setscrew and washer. To extract spindle use extractor. Screw hexagon part of extractor on threaded part of idler spindle. Place sleeve over this part and over idler spindle until end of sleeve takes a bearing on boss of crankcase round idler spindle flange. Screw nut on thread which projects from sleeve. Upon tightening nut idler spindle can be withdrawn from crankcase.

Camshaft Front Bearings

Drift and tommy bar can be used for removing this bearing.

SYSTEMATIC INSPECTION OF "GIPSY MAJOR" AERO ENGINE

After thoroughly cleaning all parts an inspection should be carried out, with particular attention to the points mentioned below :

Cylinder Heads

Examine valve seatings for pocketing or pitting. If these are very pronounced a seating cutter should be used to true up seats before valves are ground in.

Valve Seatings

If the seating on the valve itself is pitted or stepped, this should be ground to the correct angle, namely, 30 degrees, before grinding with the cylinder head. Any signs of picking up or roughness on the valve stems should be smoothed off and polished with superfine emery cloth.

If Valve Stems are Worn

If valve stems or guides are worn beyond limits, new parts should be fitted. To remove valve guides, use extractor. If a valve guide is removed for any reason, the Hallite washer between guide and valve gear casing should be removed. To avoid damaging the ends of the valve guides on replacement, the soft drift provided should be used.

Valve Rocker Brackets

Bolts holding valve rocker bracket should be checked for tightness and tightened up and repinned if at all slack. Should valve rocker bracket be removed from cylinder head, the following points should be noted before replacement.

Cylinder Head Joint

All joint faces should be thoroughly cleaned and a new joint made between head of cylinder and valve gear casing and between casing and valve rocker bracket. L'Hermetical or similar jointing compound should be used for these joints.

Rocker Bush and Pads, and Tappets

Check fits of rocker bush on spindle. The minimum and maximum fit allowances will be found on the clearance charts. Check up rocker pads for wear. If wear is only slight, they can be stoned smooth, but if contour of pad is badly affected a new pad should be riveted in rocker. Check up ball end in rocker and socket on tappet rod for any signs of pitting or undue wear. If pitted, however slightly, replace by new.

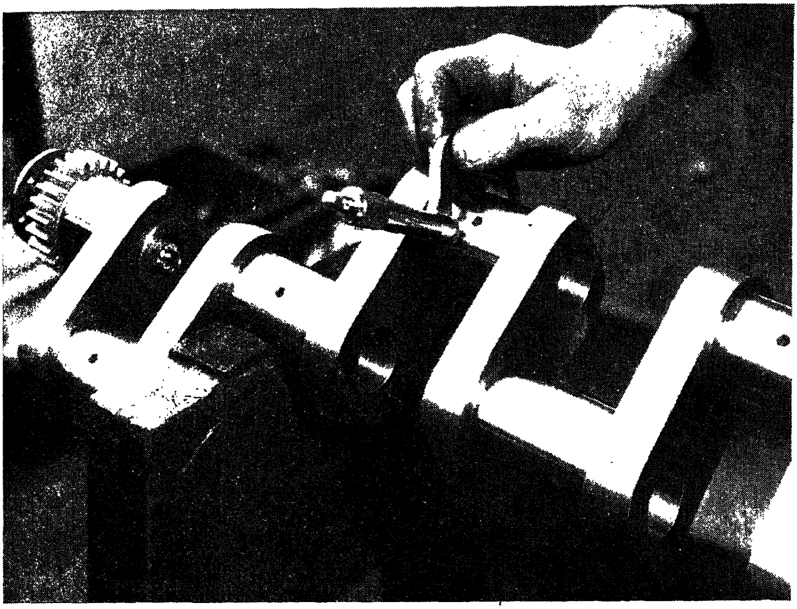


Fig. 22.—CHECKING CRANKSHAFT PIN FOR SIZE AND OVALITY.

Pistons

These should be checked for cracks, wear in gudgeon pin bores, wear in ring grooves and wear on diameter. Minimum and maximum dimensions are given in the Table of Clearances. Piston rings should be checked for blowing by loss of spring or excessive gap. If piston is inserted in the cylinder, the crown can be used for squaring up rings when checking gap. Fit piston ring to piston for checking ring groove clearance. Before doing this make sure that the ring grooves are free from carbon.

Gudgeon Pins

Check up for wear and cracks. Check fit in connecting rod against sizes given in the Table of Clearances.

Cylinders

Check up for wear, ovalness of or scoring in boxes.

Connecting Rods

Check small end bores for wear and big end and small end bores for alignment (see Table of Clearances). Rods to be polished, etched and examined for fatigue cracks.

Connecting Rod Bearings

Check for adhesion of white metal, cracks and scoring. Assemble in connecting rod and check on shaft for clearance on sides and diameter. (See Table of Clearances.) Do not face off cap to use worn bearings; fit new bearings.

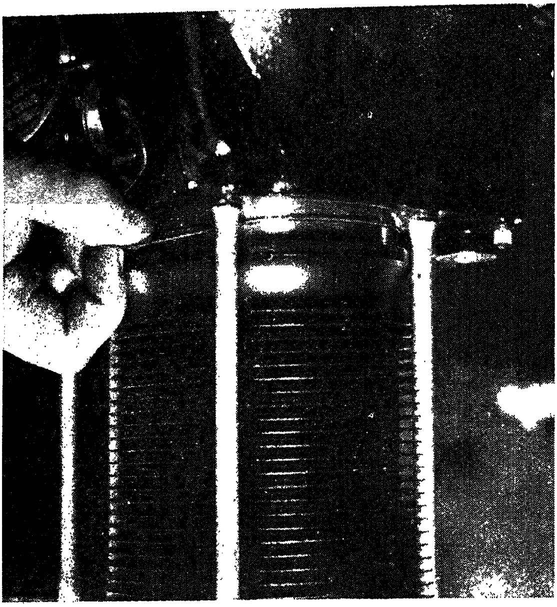


Fig. 23.—WHEN REASSEMBLING, THE DERMATINE RING BETWEEN CYLINDER FLANGE AND CRANKCASE SHOULD BE REPLACED BY NEW.

Crankshaft

Check for scoring, eccentricity or ovalness of main and big end journals. If scoring is deep, or if eccentricity or ovalness is outside limits given, the shaft should be reground. The taper for airscrew boss should be examined for any signs of picking up. Picking up marks should be carefully eased off and airscrew boss should be lapped on very lightly with fine abrasive.

Main Bearings

Check for cracks and scoring. Assemble in crankcase, and check for clearance on diameter of crankshaft. (See Table of Clearances.) Do not face off caps to use worn out bearings; fit new bearings.

Airscrew Boss

Carefully ease off any picking up marks. Should engine have been in a crash it is as well to check up boss to see that the flange is true with bore of taper.

Crankcase

Check for general condition and any signs of cracking. Check tightness of all studs, especially main bearing studs. Should the camshaft bearing bores be worn sufficiently to be unserviceable, the crankcase will have to be returned to the makers for bushes to be fitted.

Top Cover

Check for general condition and any signs of cracking. Check tightness of studs.

Camshaft

Check for any signs of flaking of case or chipped edges on cams, and general condition of bearings. Any roughness on edges of cams should be stoned smooth.

Timing Gear Cover

Check for general condition and any signs of cracks. Check tightness of studs.

All Ball Races

Check after washing very thoroughly, for any signs of roughness or pitting of balls or tracks. If any signs, however slight, scrap ball race and fit new part. The amount of running the ball races have done is no guide to their condition, as they can be attacked by condensation if the engine is allowed to stand idle for long periods.

Gears

Check for chipping, wear or pitting. If chipping is not very pronounced and is confined to edges of teeth, these places can be stoned smooth. Gears worn or pitted very badly should be replaced by new. (See Table of Clearances for backlash of various gears.)

Check for tightness of bearings in housings, fit and condition.

Tappets and Guides

Check for fit of tappet in guide and condition of bearing surfaces, also heel of tappet for flaking of case, cracks and contour.

Induction Manifold

Inspect and carry out pressure test at 25 lbs. sq. in. for heater jacket, and 30 lbs. sq. in. for pipe.

Carburetter, magnetos, starter and accessories should also be completely overhauled.

REASSEMBLY

After all parts have been cleaned,

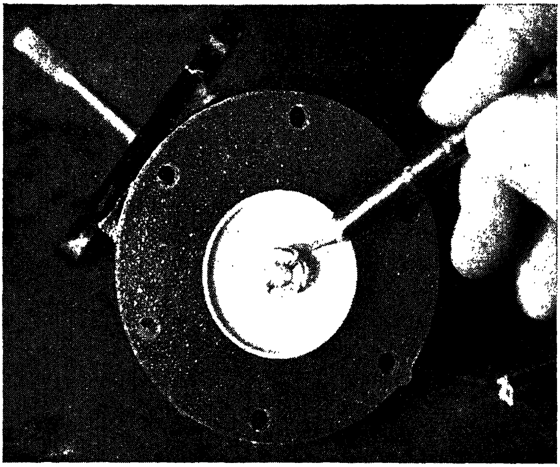


Fig. 24.—When reassembling fuel pump, the diaphragm should always be renewed.

See that the centre nut is tight on the new diaphragm.

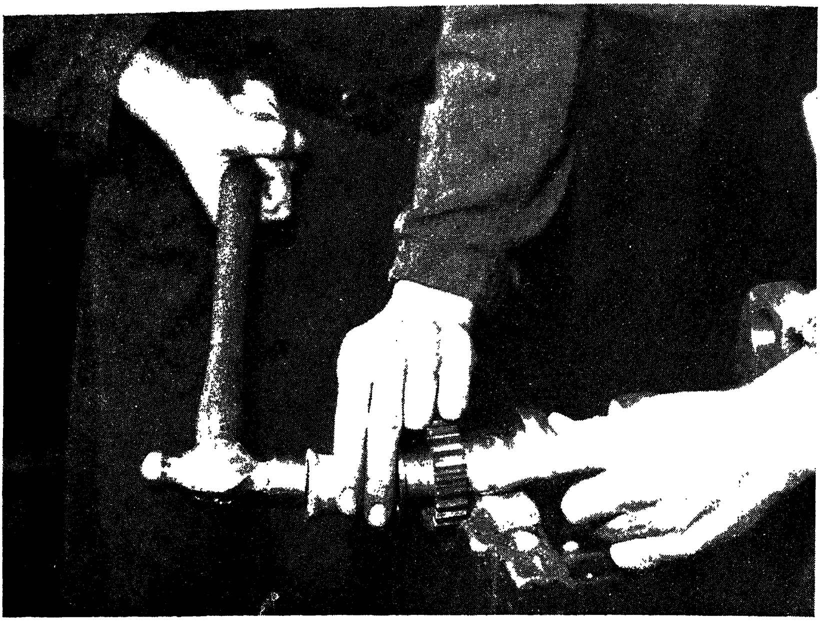


Fig. 25.—WHEN REPLACING CRANKSHAFT GEAR IN CRANKSHAFT MAKE SURE THAT THE FRONT FACE OF GEAR IS TIGHT AGAINST REAR FACE OF CRANKSHAFT.

This should not be pulled into place by bolt, but should be tapped right home and retained by bolt.

cylinder heads, etc., decarbonised and valves ground in, reassembly can take place in reverse order to that on dismantling list.

Parts which should be Replaced by New

The following parts should be replaced by new :—

Dermatine ring between cylinder flange and crankcase.
Dermatine ring between tappet guide flange and crankcase.
Copper and asbestos washers throughout oil system.
Copper and asbestos washers between cylinder head and cylinder.
Hallite washers on induction ports.
Copper and asbestos washers on exhaust ports.
Hornex rings in valve gear casings.
Dermatine ring between tachometer attachment casing and timing gear cover.
Hallite washers between valve guides and valve gear casings.
Dermatine rings at each end of tappet casing tubes.
Diaphragms of fuel pumps.
Hallite washer between carburetter and induction manifold.

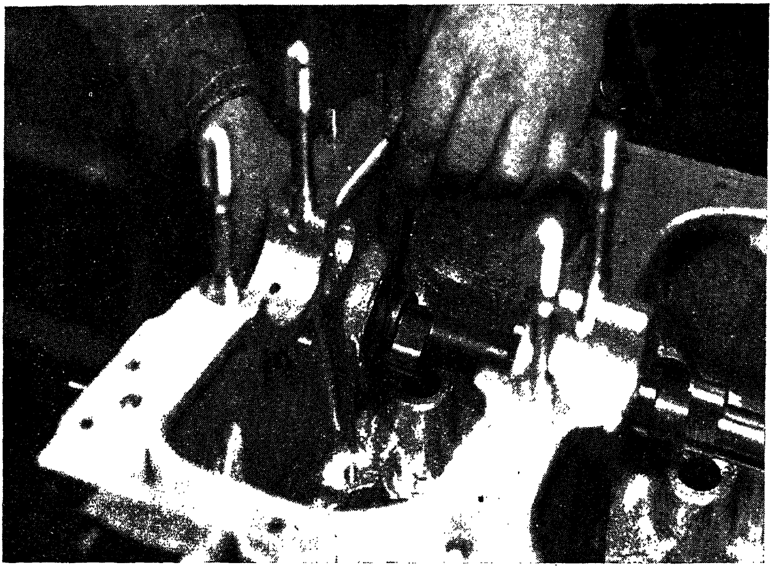


Fig. 26.—CHECKING END FLOAT OF CAMSHAFT WHEN REASSEMBLING.

The clearance should be checked by inserting feeler between the front of rear camshaft bearing and rear of shoulder on camshaft. The correct end float is given in the Table on page 47.

Crankshaft Reassembly Notes

The following points should be noted during assembly :—

1. All oil ways should be well blown through with compressed air.

2. All parts should be oiled freely during assembly.

3. When replacing crankshaft gear in crankshaft make sure that front face of gear is tight against rear face of crankshaft. This should not be pulled into place by bolt but should be tapped right home and retained by bolt.

4. Crankshaft ball race should be tapped into place on shaft, using soft drift, or a piece of tubing which will bear only on inner race. Nut should be pulled up tight, by using the ring spanner, and should be locked by bending up one of the tabs on tab washer into one of the slots in nut.

Magneto Driven Shaft

5. When reassembling magneto driven shaft in timing gear cover, the following points should be noted :—

Housing ball race and oil retainer must be fitted on starboard side.
Make sure that oil baffles (magneto drive) are in place, one on each side of magneto driven gear.

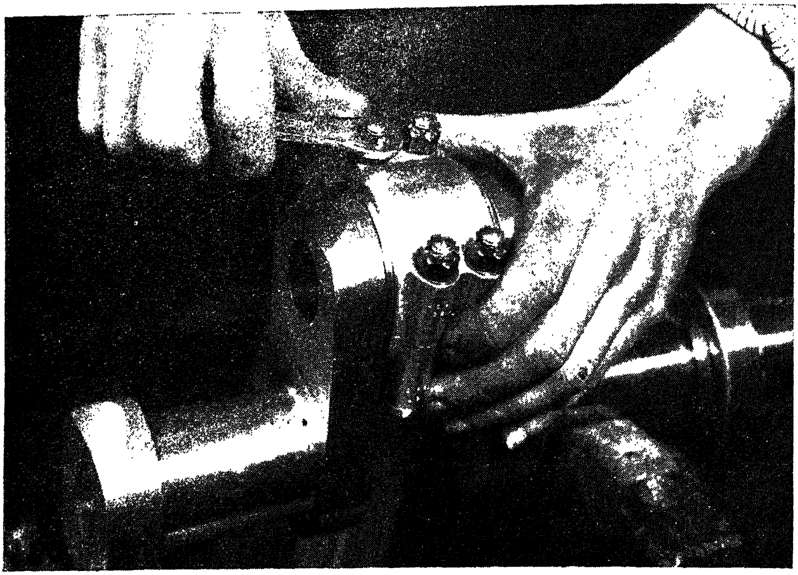


Fig. 27.—REFITTING CONNECTING ROD TO CRANKSHAFT.

The big end nuts should be tightened up as much as possible with a type T 1900 spanner. Under no circumstances should any other spanner be used, as this tool has been specially designed to avoid any unnecessary stress being applied.

Tachometer Drive Attachment

6. When reassembling tachometer drive attachment, dual or single engine speed type, the following points should be noted :—

If new spindle or bushes have been fitted, the end float will have to be obtained by facing off bushes. End float necessary will be found in Table of Clearances.

7. When reassembling tachometer drive attachment, single quarter engine speed type, the following points should be noted :—

If new high speed shaft or bushes have been fitted, the end float will have to be obtained by facing off the bushes.

If new low speed spindles or bushes have been fitted, the end float will have to be obtained by facing off the washers fitted on each side of spiral gear. The screwed bushes carrying the low speed shafts are numbered 1 and 2, and it is important that these are fitted correctly in the casing, which is also marked. The threads on these parts are dissimilar in diameter as an added precaution against incorrect fitting.

Oil Pumps and Camshaft

8. Upon reassembly of oil pump, the following points should be noted :—

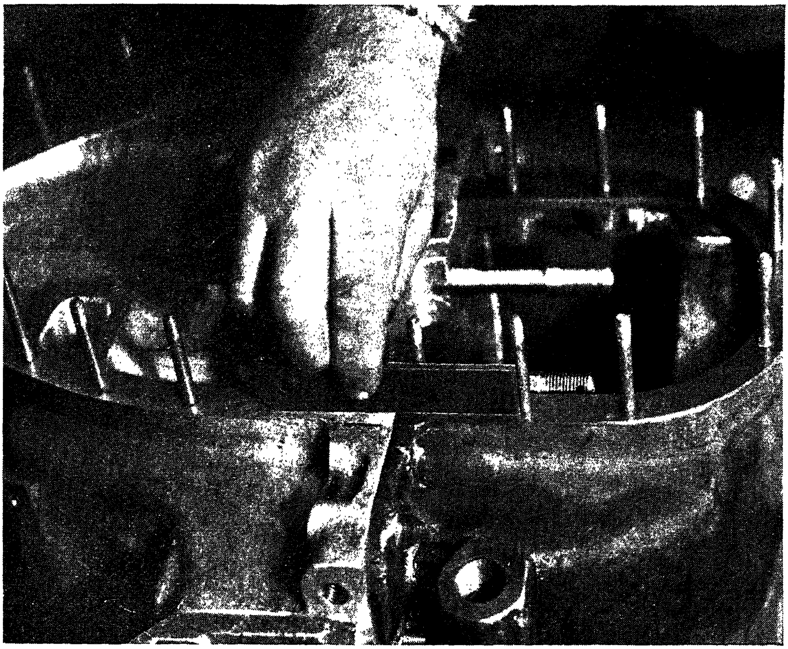


Fig. 28.—WHEN REPLACING TOP COVER, LINE UP FRONT AND REAR FACINGS ON TOP COVER AND CRANKCASE BEFORE TIGHTENING BOLTS DOWN.

This may be done with a rule or small straightedge laid across rear facing of crankcase and top cover.

If new spindle or bushes have been fitted, the end float will have to be obtained by facing off bushes. (See Table of Clearances.)

9. Camshaft should be replaced in crankcase before fitting tappets and guides. This will avoid any chance of tappets falling out while tappets and guides are being fitted to crankcase. When camshaft is assembled in crankcase, it should turn quite freely, and end float as given in the Table of Clearances should be checked by inserting feeler between front of rear camshaft bearing and rear of shoulder on camshaft. Dermatine rings should be in place on tappet guides before these are fitted to crankcase.

The Bearing Nuts, Pistons, Cylinders, etc.

10. When refitting connecting rods to crankshaft, the big end nuts should be put up as tight as possible, using special spanner. Under no circumstances should any other type of spanner be used as this tool has been specially designed to avoid any unnecessary stress being applied to the big end bolts. Nuts should not be slacked back to get split pin in. Should slot in nut go beyond the hole, the nut should be faced off slightly to bring the next slot in line.

11. Main bearing nuts should be put up dead tight, using ring spanner. Remarks on big end nuts also apply in this case.

12. At this stage it is as well to prime the oil gallery with oil under presssure to check possible leaks and to make sure that leak holes in connecting rods are clear.

13. Crankshaft in this condition should turn quite freely by hand.

14. If any new pistons or connecting rods have been fitted, piston and cylinder should be assembled on crankcase before top cover so that side clearances can be checked against figures given in the Table of Clearances.

15. When replacing top cover, line up front and rear facings on top cover and crankcase before tightening bolts down. Bolts should be tightened evenly all round before tightening right up. A good jointing compound, such as L'Hermetical, should be used on this and other metal to metal joints.

16. Invert engine.

17. Place nuts and spring washers on tappet guides.

18. When fitting crankcase front cover, centralise by means of gauge and feelers before tightening nuts right up.

19. Proceed with assembly of pistons, cylinders and heads.

Valve Timing

20. The valve timing can now be proceeded with as follows :—Set crankshaft so that pointer on boss comes opposite inlet closed position on crankcase front cover. Set tappet on No. 1 cylinder to ·005 clearance. Set camshaft so that clearance is just taken up on inlet closed position. Idler gear should enter both crankshaft and camshaft gears when in position on idler spindle. If crankshaft gear or camshaft gear has been changed timing will have to be reset using the four keyways in camshaft gear. To reset timing place camshaft and crankshaft in correct positions, mesh idler gear with crankshaft gear, and try camshaft gear in the four positions allowed by the keyways and fit in the position found nearest correct. Check valve timing on all valve positions on No. 1 cylinder. It is possible to get timing within 2 or 3 degrees in all positions.

21. When reassembling idler gears, the correct end float should be obtained by varying the number of shims between flange on idler spindle and thrust race. When tightening nut on rear end of idler spindle, do not strain up unnecessarily, as this will shear the small locating peg and probably loosen the spindle in the crankcase.

22. If any new gears have been fitted, backlash should be in accordance with Table of Clearances.

23. The oil pump when assembled to timing gear cover should turn freely by hand. Should any tightness be felt it should be rectified before timing gear cover is fitted to engine.

24. Before replacing timing gear cover check locking of nut holding oil pump driving gear to spindle. While timing cover is being fitted make

sure that oil pump gear is in mesh with camshaft gear before timing gear cover is pushed home.

25. When replacing tachometer drive attachment make sure that Dermatine ring is in place, and that oil holes are clear in casing.

26. Oil pipes should be blown out with compressed air before being fitted to engine. When fitting gear jet pipe make sure that small filter is in position in banjo.

27. If new airscrew boss has been fitted to crankshaft, make sure that clearance is correct on top of key and that boss is home on taper and not hanging upon key in any way.

28. The portion of the scraper ring which bears on the cylinder wall should be furthest from gudgeon pin.

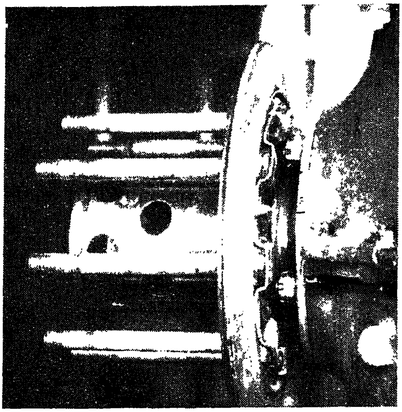


Fig. 29.—TO TIME MAGNETOS.

Set pointer on airscrew boss opposite magneto advance marking on oil retainer, as shown. The magnetos should then be set with points about to break, with cam ring in full advance position and the magnetos offered up into position.

Reassembling Cylinder Heads

29. When reassembling cylinder heads, use valve spring compressor to hold collars down while replacing collets.

30. Pistons are made to a standard weight, so no selection is necessary if a new part is fitted.

31. When refitting circlips on gudgeon pins, use circlip expander. Circlips when fitted must be a tight fit in groove in gudgeon pin. If at all loose they must be renewed.

32. Piston ring gaps should be spaced apart equidistantly before fitting to cylinders. When replacing cylinders use piston ring compressor to hold piston rings in place. As cylinder is pushed up, the clamp will be pushed off piston and can be withdrawn before cylinder is right up in place.

33. While cylinder heads are being put up, make sure that bridge pieces, thin and thick washers and nuts, are put in place. Cylinder nuts should be screwed up just sufficiently to hold heads, and the heads should be lined up to a straight edge against the inlet port facings. The cylinder heads should then be tightened up by tightening nuts on opposite corners alternately. The nuts, finally, should be screwed up firmly and evenly, using special spanner or in any case with a spanner the handle of which should not exceed 4½ in. in length.

34. When replacing the valve gear covers the knurled stud should be tightened up just sufficiently to make an oil-tight joint between cover and casing. Do not strain covers by tightening studs unnecessarily.

35. Nuts on inlet and exhaust manifold should be tightened up progressively. Do not strain unnecessarily when tightening.

To Time Magnetos

36. To time magnetos set pointer on boss opposite magneto advance position on oil retainer. Set magnetos with points about to break with cam ring in full advance position, and offer up magnetos. Turn rubber coupling round until both sets of teeth will enter, one set in magneto coupling, and the other set in coupling in magneto driven gear. No. 1 cylinder is wired to lower front terminal on both magnetos. Cylinders are numbered from airscrew end of engine.

Replacing Airscrew

37. To hold airscrew boss, while tightening up crankshaft nut, the airscrew can be slipped on bolts. The box spanner can be inserted in centre hole of airscrew to tighten up nut. Use tommy bar with this box spanner.

38. When replacing the airscrew the following points should be noted. The nuts on airscrew bolts should be tightened up alternately on opposite bolts. The amount of thread should be checked to ascertain that the nuts are not bottoming on end of thread before airscrew is tight.

Running in after Assembly

39. When assembly is complete the engine should, if possible, be run on a special stand and driven by external means. If this equipment is not available engine should be run in at 800–900 r.p.m. for one hour before being subjected to the regulation endurance test. After the endurance, power and consumption test the engine should be stripped sufficiently for the examination of new parts which have been fitted, reassembled and subjected to a final proof run.

40. The list headed "Table of Clearances" to be followed during engine overhaul are for the checking of used parts to determine their suitability for further service.

Operating Routine

In addition to the daily inspection, cleaning of fuel filters, and running up of engines, the following maintenance routine is recommended :—

AFTER 25 HOURS FLYING

1. Dismantle, clean, reset points and test sparking plugs.
2. Clean suction and pressure oil filters. (Auto-Klean, rotate daily.)
3. Clean fuel filter.

4. Check magneto contact breaker gaps and reset if necessary.

5. Check valve clearances and reset if necessary.

6. Before replacing valve gear covers, add engine oil to bring up to level of ring on vent pipe.

7. Drain oil system and fill with fresh oil.

8. Remove and check carburetter jets and flush float chamber.

9. Check tightness of airscrew bolts. This should be done more frequently if airscrew is new or if the aeroplane is operating in a hot climate.

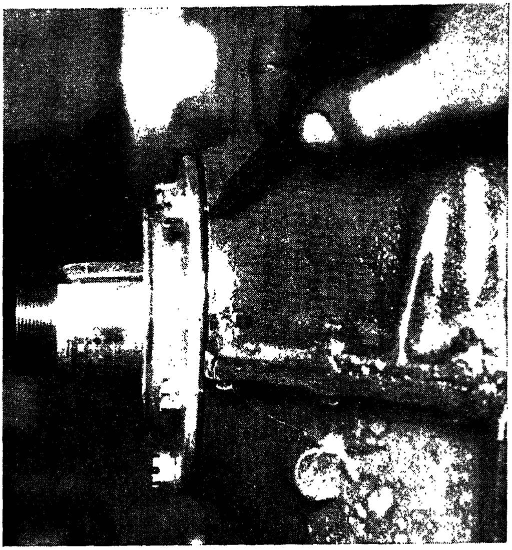


Fig. 30.—Reassembling front cover to crankcase.

Shims fitted to give gap of ·005 in. before bolts are tightened to ensure nip on thrust race.

Attention is drawn to the necessity for periodical lubrication of all engine control moving parts. Cases of seizure have occurred owing to neglect in carrying out this simple operation. Some thin type of oil, or failing this, ordinary engine oil can be used, and owing to the inaccessibility of some of the control parts, it will be found that the oil can best be applied by means of a small brush. The moving parts that require attention include: control shaft main bearings, ball ends, bell crank bearings and cams and plates for magneto control.

After 50 hours. Early engines with "Tecalemit" filter; change element.

After 250 hours. Engines with "Auto-Klean" filter; clean out filter and filter casing.

After 750 hours. Engine should be removed from the airframe and given a complete overhaul and bench testing.

Note. It must be understood that under this schedule the necessity for periodical examination of the engine still exists and that should any obvious defect such as loss of compression on one cylinder become evident the engine must be stripped sufficiently for examination and rectification.

VALVE TIMING AND TAPPET CLEARANCES

In September, 1934, a modification was introduced on the "Gipsy Major" engine increasing the inlet valve clearance from ·005 in. to

·010 in. (when steel tappet rods are fitted) and ·015 in. (when duralumin rods are fitted).

1. A modified front cover has been introduced; the modification consists of the deletion of all timing positions except B.D.C., exhaust valve opening and magneto advanced position. All existing front covers may be brought up to date in this respect by deleting the markings as indicated.

2. Valve timing must be carried out in the exhaust valve opening position.

3. In all cases the tappet clearance is measured between the thimble on the valve stem and the pad in the rocker.

REPAIR SCHEMES

The manufacturers of the "Gipsy Major" engine have available for the use of *bona fide* operators and servicing organisations the following approved repair schemes:—

1. Regrinding undersize of crankshaft journals and pins.
2. Supplies of undersize bearings.
3. Cuttering of valve seatings in cylinder head.
4. Regrinding of cylinder barrels ·005 in. oversize.
5. Supplies piston rings for ·005 in. oversize.
6. Regrinding of cylinder barrels ·010 in. oversize.
7. Supply pistons and rings ·010 in. oversize.
8. Machining of worn oversize piston to standard size.

TABLE OF CLEARANCES

To be followed during Overhaul of "Gipsy Major" Engine

		METRIC.		INCHES.	
		Min.	*Max.*	*Min.*	*Max.*
Main Bearings ..	On diameter	·064	·127	·0025	·005
,, ,, ..	Side ..	·500	—	·020	—
Crankshaft ..	End float..	·125 Nip		·005 Nip	
Connecting Rods	On diameter big end bearing ..	·037	·120	·0015	·005
	Side big end bearing	·100	·254	·004	·010
	Between side of small end and boss of piston	1·00		·040	—
Gudgeon Pins	On dia. in piston..	·001	·068	·000	·0027
	On dia. in connecting rod ..	·006	·076	·00025	·003
,,	End float in piston ..	·900	1·5	·0355	·059
Pistons ..	On dia. in cylinder 1st land	·750	1·15	·0295	·045
	,, ,, 2nd ,,	·650	1·05	·0255	·041
	,, ,, 3rd ,,	·650	1·05	·0255	·041
	,, ,, skirt (top) ..	·450	·81	·01775	·032
,, ..	,, ,, ,, (bottom)	·370	·71	·0145	·028
Piston Rings	In grooves, top ..	·175	·33	·007	·013
	Gap, 1st	·66	1·5	·026	·060
	In grooves, 2nd ..	·175	·33	·007	·013
	Gap, 2nd ..	·66	1·5	·026	·060
	In grooves, scraper	·125	·23	·005	·009
,, ...	Gap scraper	·45	1·25	·018	·050

Diametral clearances on pistons and ring gaps to be measured with pistons placed at half-stroke position in cylinder barrels.

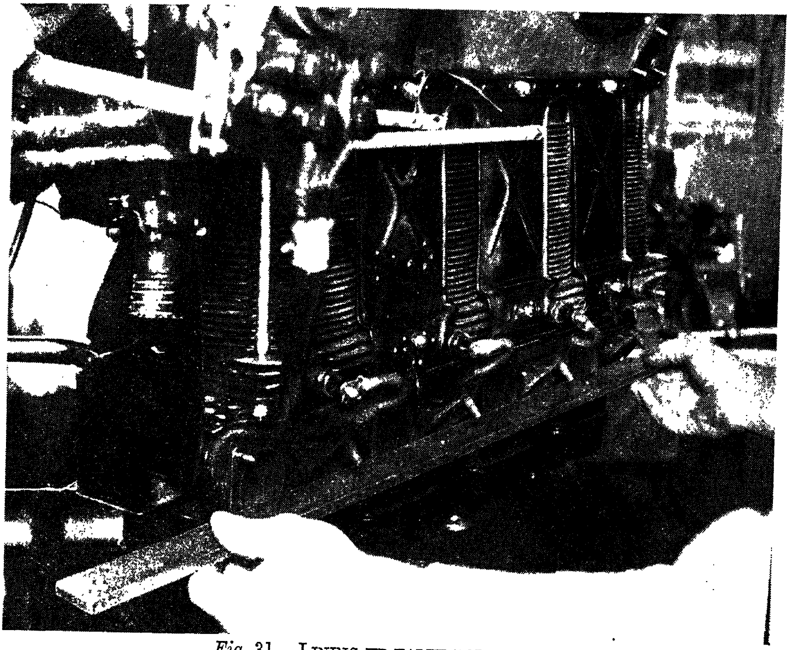


Fig. 31.—LINING UP VALVE PORT FACES.

This is done by means of a steel straightedge held along the faces of the ports.

TABLE OF CLEARANCES—*continued.*

		METRIC.		INCHES.	
		Min.	*Max.*	*Min.*	*Max.*
Cylinders	Ovality	—	·076	—	·003
,,	Taper	—	·200	—	·008
Camshaft	On dia. bearings, front	·025	·190	·001	·0075
	,, ,, 2nd	·025	·165	·001	·0065
	,, ,, 3rd	·025	·165	·001	·0065
	,, ,, 4th .	·025	·165	·001	·0065
	,, ,, rear .	·025	·190	·001	·0075
	End float.. .. .	·025	·150	·001	·006
Valves ..	On dia. stems exhaust .	·080	·200	·003	·008
,, ..	,, ,, inlet .	·050	·200	·002	·008
,, ..	Clearances cold .. .	·125		·005	
Rocker Bushes	On dia. in rocker .	·012	·250	·0005	·010
,, ,,	In bore on spindle .	·012	·114	·0005	·0045
Tappets..	On dia. in guide ..	·012	·114	·0005	·0045
,, ..	On flats in guide..	·012	·150	·0005	·006
Pump Gears	On dia. gears	·098	·175	·004	·007
	End float..	·075	·200	·003	·008
	Backlash..	·200	·380	·008	·015
,, ,, ...	On dia. bearings..	·018	·114	·0007	·0045
Pump Gear Spindle (Driver)	End float..	·038	·178	·0015	·007
Timing Gears Spur ..	Backlash..	089	·380	·0035	·015
Magneto Driving and Driven Gears ..		120	·380	·005	·015

TABLE OF CLEARANCES—*continued.*

		METRIC.		INCHES.	
		Min.	*Max.*	*Min.*	*Max.*
Idler Gear with Bushes	End float	·051	·110	·002	·004
Idler Gear bushes, front and rear	In bore on spindle	·065	·140	·0025	·0055
Oil Release Valve	On dia. in bush	·012	·076	·0005	·003
Tach: drive spindle (single and 1 : 1 dual)	On dia. oil thrower	·025	·102	·001	·004
Ditto	On dia. bearings	·025	·102	·001	·004
Ditto	End float	·110	·300	·0045	·012
Tach: spiral gear (single and 1 : 1 dual)	Backlash	·190	·500	·0075	·020
Tach: spur gears (1 : 1 dual)	„	·100	·250	·004	·010
Tach: driven gear (1 : 1 dual)	On dia. bearing	·025	·102	·001	·004
Ditto	On dia. oil thrower	·025	·102	·001	·004
Ditto	End float	·075	·300	·003	·012
Oil Throwers Mag. Cross Shaft	On diameter	·053	·152	·002	·006
Mag. Cross Shaft	End float	·070	·300	·00275	·012
Simms Coupling (Impulse side only)	„	·500		·019	
Tach: driving spindle (4 : 1 dual)	„	165	·300	·0065	·012
Tach: driven spindle (4 : 1 dual)	„	076	·300	·003	·012
Tach: driving and driven spindles (4 : 1 dual)	On dia. bearings	025	·102	·001	·004
Ditto	On dia. oil throwers	025	·102	·001	·004
Tach: spiral gear and idler spiral gear	Backlash	190	·500	·0075	·020
Tach: driver and driven gears (4 : 1 dual)	„	100	·300	·004	·012

INSPECTION OF AIRFRAMES

SECTION I

By Squadron-Leader K. L. Boswell, A.F.R.Ae.S.

Introduction

THE serviceability of an aeroplane and the safety of its occupants are dependent not only on the correct running of the aero-engine, but also on the functioning of fuel, oil and cooling systems, the operation of controls and moving parts, and the ability of each part of the airframe structure to withstand the varying loads imposed upon it during take off, flight and landing. Deterioration, corrosion, defects inherent in the design, defects due to workmanship or material, lack of lubrication, excessive wear and cracked or broken parts, may all contribute to or cause an accident. It is essential, therefore, to ensure that every part of the aeroplane is inspected at regular intervals and also when any abnormal stresses occasioned by such incidents as heavy landings are suspected.

Object of Inspections

2. It should be realised that inspection is only a means to an end and not an end in itself. It is of little use to discover a defect if the defect is not remedied before the aeroplane is allowed to fly. It can be said, therefore, that the object of inspection is to disclose the necessity for doing work on the aeroplane. This work is termed maintenance. It does not cover the work to be done during overhauls.

System of Inspections

3. Normally a staff of qualified engineers is employed to do inspection and maintenance work. However competent and experienced this staff may be, there is always a possibility of a vital part being overlooked unless an organised system of inspection is followed. Moreover, both time and labour are saved if the work is done systematically.

Influence of Design

4. The system adopted and the ease with which inspections can be done will be governed to a large extent by the design of the aeroplane. Unfortunately, in the race for performance, the development of new methods of construction and the necessity for fitting complicated equipment in modern aeroplanes, designers have so much to think about that ease of inspection and maintenance sometimes tends to be regarded as of secondary importance.

Consideration of the following points at the early design stage would, however, do much to simplify the task of the inspectional staff and contribute towards efficient maintenance :—

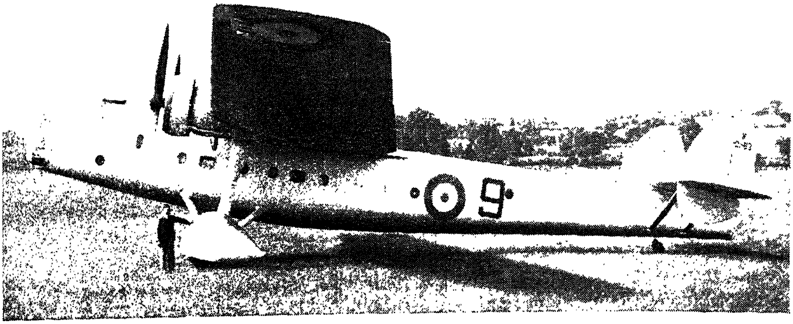


Fig. 1.—BRISTOL TYPE 130 BOMBER TRANSPORT.

(i) The materials and type of construction employed, their liability to deterioration, corrosion and damage, and the facility with which they lend themselves to simple repair.

(ii) The selection of an efficient anti-corrosive treatment and its careful application.

(iii) The provision of suitable inspection panels or doors giving easy access to parts requiring frequent attention. These should not be limited to working parts, but should allow access to attachment fittings liable to failure after heavy landings, pipe unions, tanks where they are fitted inside the main planes, and generally permit inspection of the interior structure of all parts of the airframe.

(iv) The grouping and accessibility of lubrication nipples.

(v) The provision of adequate bearing areas for working parts.

(vi) The accessibility of instruments, equipment and auxiliary units.

(vii) The fitting of replaceable bushes to obviate the necessity for oversize pins or bolts.

(viii) The necessity for interchangeability of all parts or components.

Scope of Inspections

5. As has already been stated, the main object of inspection is to disclose the necessity for doing maintenance work, but whatever system is adopted it must also cater for refuelling, lubrication and other essential services. It must be framed to reveal defects due to faulty design, material or workmanship, excessive wear of bearings and working parts, and deterioration or corrosion in their early stages. It should impose the least restriction upon flying; be designed to eliminate extensive partial overhauls likely to result in protracted unserviceability; obviate dislocation due to change of inspectional staff and be co-ordinated with any defect or modification procedure. In short, it must provide for periodical inspection and progressive repair and replacement.

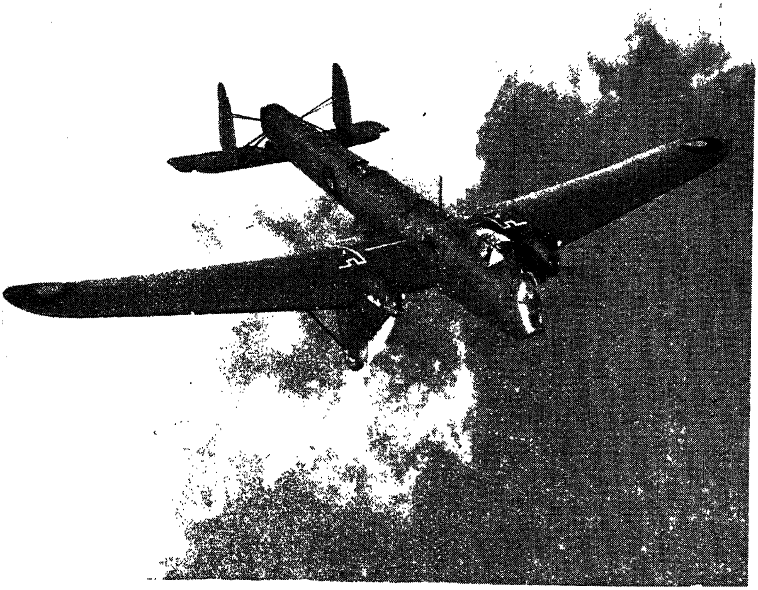


Fig. 2.—TWIN-ENGINED MONOPLANE.
The Fairey "Hendon."

Periodical Inspections

6. In the choice of a system of periodical inspections, many factors may have to be considered. Possibly the most important are :—

(i) the type of aeroplane and construction, *e.g.*, whether landplane or seaplane, and whether it is of wooden, metal or composite construction ;

(ii) the operations or service on which the aeroplane is employed and the climatic conditions under which it is operating ;

(iii) the nature and surface of the landing grounds and the housing facilities provided.

The efficiency of any system will depend on its flexibility to allow for varying conditions. Experience has shown that it is practicable to build up schedules of inspections for each individual type from a standard basis and to frame the maintenance instructions to give the necessary flexibility.

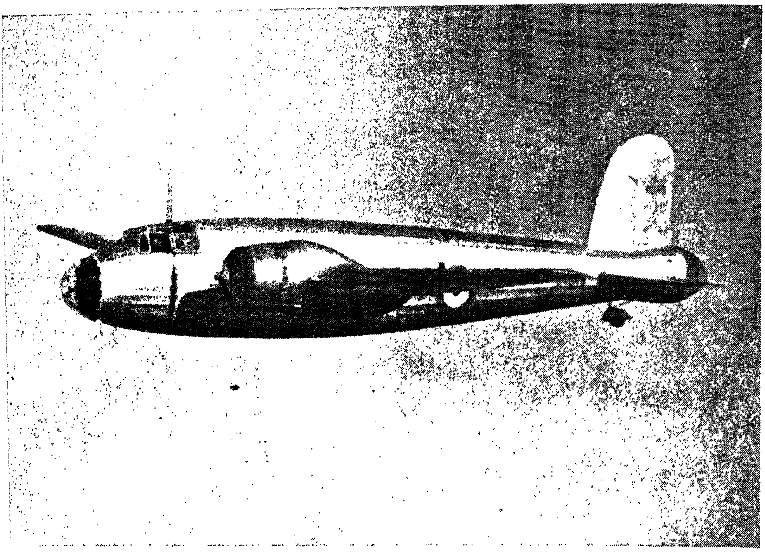


Fig. 3.—VICKERS "WELLINGTON MK. I." TWIN-ENGINED HIGH PERFORMANCE LONG RANGE BOMBER.

Bristol " Pegasus " Engines are used and the aeroplane is of Geodetic construction.

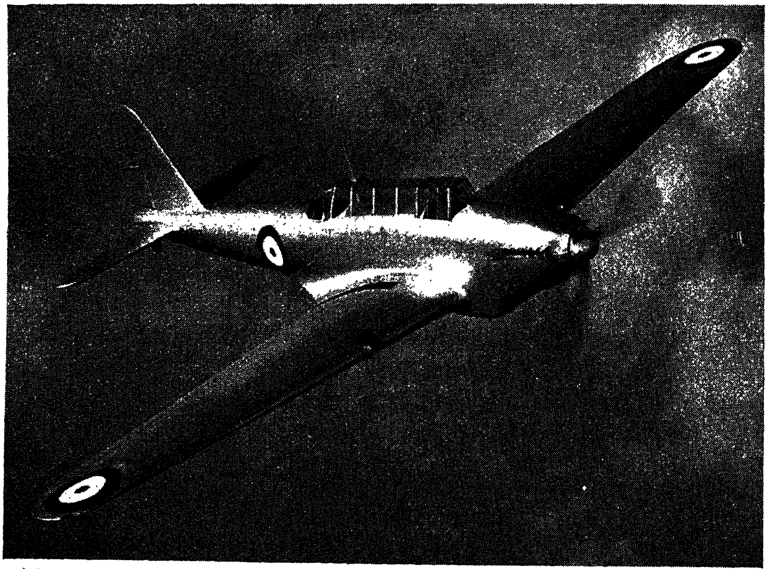
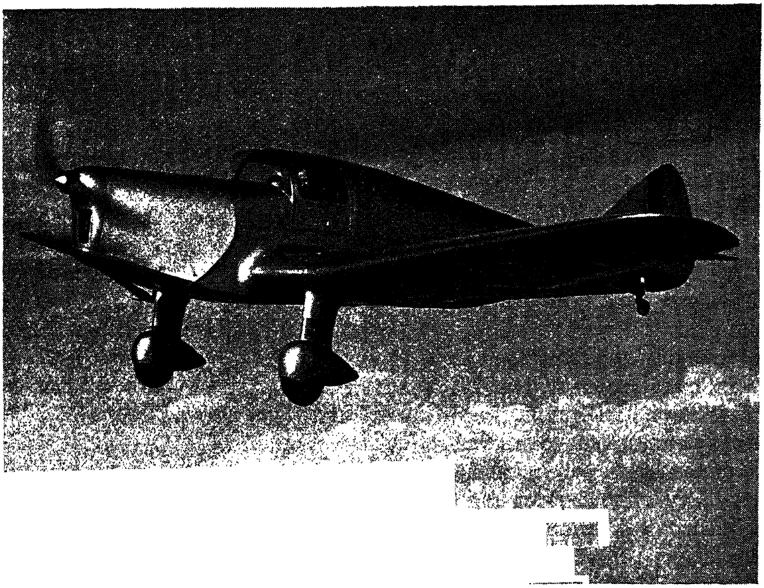


Fig. 4.—SINGLE-ENGINE LOW WING MONOPLANE WITH RETRACTABLE

" Battle." The engine is a Rolls-Royce " Merlin.



. 5.—SINGLE-ENGINE LOW WING MONOPLANE.
The Miles "Whitney Straight."

Suggested Basis of Periodic Inspections

7. There are probably several bases upon which a system of inspection
can be compiled, but, in general, the choice will lie between flying hours
r time It may be difficult to decide which of these is more appropriate.
ielling, lubrication, inspection of working parts and of those parts
e to failure from vibration or shock, are primarily dependent on the
m. On the other hand liability to corrosion or deterioration is
tion of time.

be

The inspections should be organised in groups in a series of graduated operations in the form of a schedule ; a typical example will be given later. At best these periodical inspections can only disclose defects due to normal wear and tear ; special inspections will have to be made when it is suspected that damage has been occasioned by abnormal stresses during handling, taxi-ing, taking off, flying manœuvres, or landing.

Periods Between Inspections

8. In this article it is assumed that the flying hour basis is accepted. It remains to determine the most suitable intervals between inspections ; any attempt to fix these arbitrarily is bound to lead to controversy. It is proposed, however, to examine a standard system which can be adapted and applied to all types of aircraft and under all conditions of operation. Experience has shown that inspection daily, between flights, and at intervals of 10, 20 or 40 and 120 flying hours is a practical basis for initial compilation of an inspectional schedule. At first sight it may appear that to call for routine inspections at such frequent intervals is unnecessary, particularly where a large passenger aeroplane is making one flight of 10 or more hours each day. The principle applies, however, if the inspections are progressive and inclusive, *i.e.*, the work to be done at the longer periods should include that scheduled for each of the shorter periods. For the large passenger aeroplane mentioned above the daily,

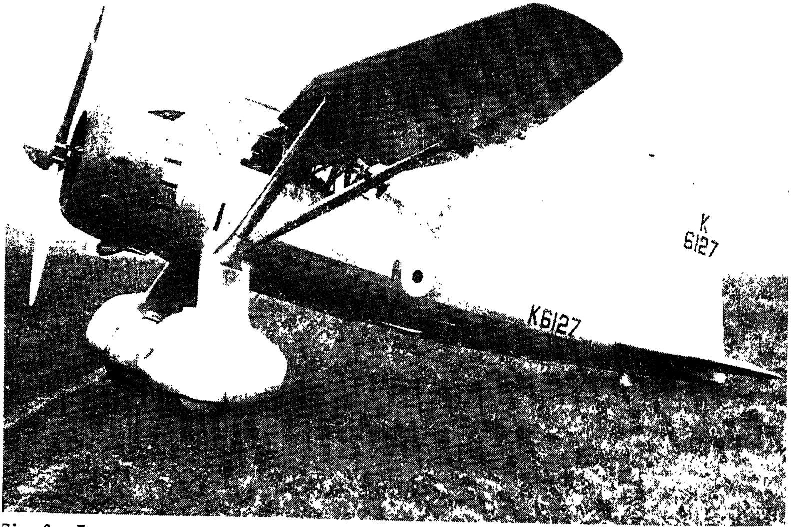


Fig. 6.—LYSANDER SINGE-ENGINE HIGH WING MONOPLANE WITH STREAMLINED UNDER-CARRIAGE WHEELS.

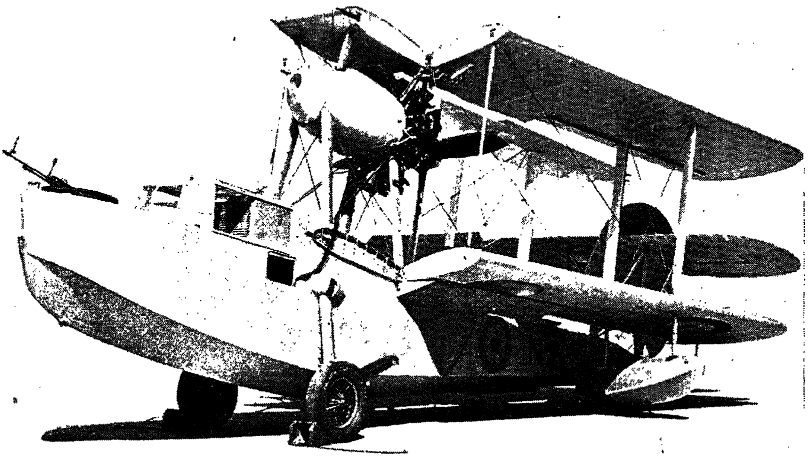


Fig. 7.—VICKERS SUPERMARINE "WALRUS" SPOTTER AND RECONNAISSANCE AMPHIBIAN FLYING BOAT.

The engine is a Bristol "Pegasus." The wings are shown folded for storage purposes.

between flight, and 10 hour inspection would be combined into one inspection.

Daily and Between Flight Inspections

9. The daily and between flight inspections are primarily intended for aeroplanes which are making a number of short flights at irregular intervals or for aeroplanes employed in flying training, where a number of short flights are made every day. A glance at the detailed operations shown in the specimen schedule under these two headings will dispel any fear that these inspections will restrict flying unduly. They cover such operations as inspection of the fuel, oil and coolant systems to ensure that these are replenished when necessary.

10 Hour Inspections

10. Well-designed and well-constructed modern aeroplanes should be capable of standing up to flying stresses for at least a period of 20 hours, but, nevertheless, a 10 hour inspection is advisable during the early stages of the life of an aeroplane. Once, however, sufficient experience

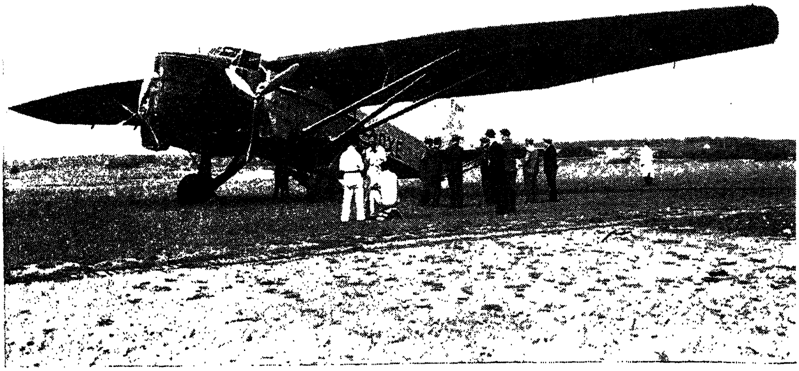


Fig. 8.—HIGH WING TWIN-ENGINED MONOPLANE.
This is the Farman 221.

has been gained of the behaviour of the aeroplane it is more than probable that this inspection may be unnecessary. If it is found to be superfluous the inspection should be eliminated by transferring the operations either to the daily inspection or to the 20 hour period, whichever is the more suitable. Instructions should be framed to permit this when the inspectional staff are satisfied that it can be done with safety.

20, 40 and 120 Hour Inspections

11. Again it may be found, as the result of experience, that certain items in the original schedule are either unnecessary or called for too frequently. Where operations are unnecessary they should be eliminated ; where they are over-frequent they should if possible be transferred to a later period. The standard intervals, however, should be adhered to once they have been fixed. If, for instance, it has been found that some items in the 20 hour inspection could be transferred with safety for a further 10 hours but not to the 40 hour inspection, it would be better to retain them in the 20 hour period rather than to complicate the system by introducing a special 30 hour inspection. It is quite impossible to compile an initial schedule for any aeroplane which will not require some alteration from time to time. It has been emphasised previously that the system must be flexible and capable of adaptation to meet local conditions. When the inspectional staff have sufficient experience

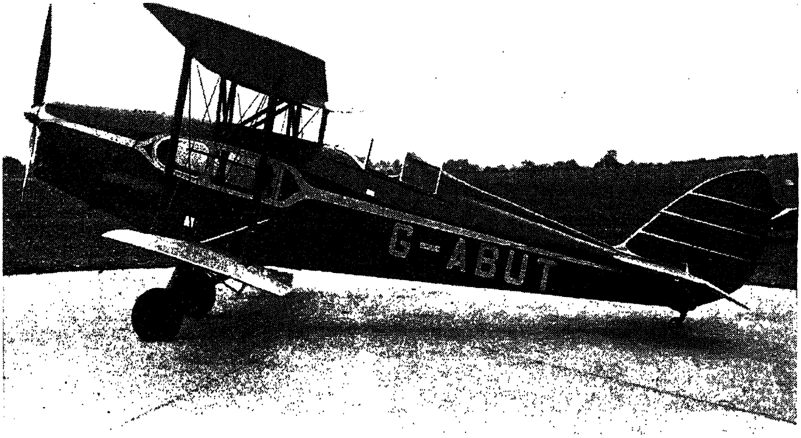


Fig. 9.—SINGLE-ENGINE BIPLANE. [*Photo by* "*Flight.*"
The de Havilland "Fox Moth."

they will be able to recommend alterations or additions to the schedules and they should be permitted to compile new schedules using the original as a guide. Where the same aeroplanes are maintained by different inspectional staffs at two or more landing grounds on a long route, it is advisable to co-ordinate the maintenance schedules, allowing only slight variations to meet local conditions.

It may also be necessary to allow some latitude to delay inspections when the aeroplane is required for a special flight. This, however, must be carefully controlled; any delay in the inspections up to the 20 hour period should be of short duration and not allowed to affect the hours at which the 40 and 120 hour inspections are due.

Progressive Repair and Replacement

12. It is essential that any work found necessary at an inspection should be done at once. This applies even to minor jobs, such as the removal of slight corrosion. Any tendency to postpone maintenance work disclosed at one inspection to a later inspection period will lead to an accumulation of work and, possibly, to a protracted period of unserviceability during which the aeroplane cannot be flown. If the system is to be efficient and economical, the instructions should ensure that both inspection and maintenance work are done progressively.

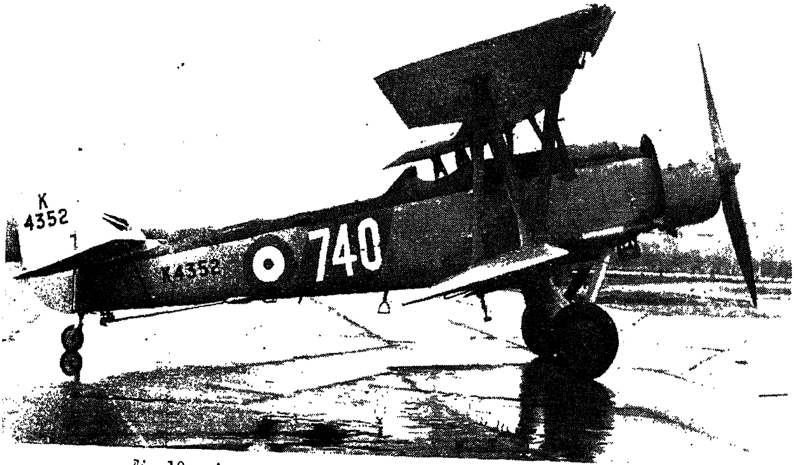


Fig. 10.—ANOTHER EXAMPLE OF A SINGLE-ENGINE BIPLANE.
The Blackburn " Shark " T.S.R. Aeroplane.

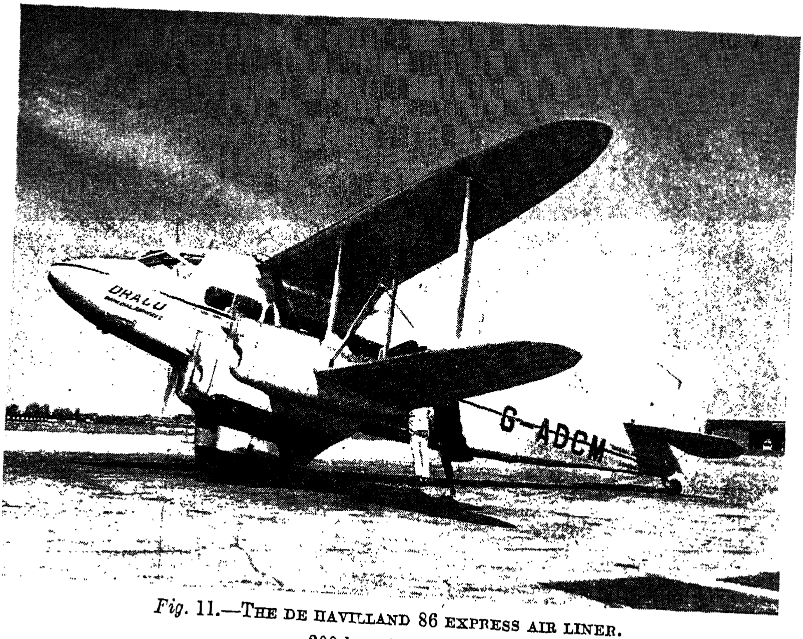


Fig. 11.—THE DE HAVILLAND 86 EXPRESS AIR LINER.
200 h.p. Gipsy Six engines.

Grouping of Inspections

13. It has already been indicated that some method of arranging the inspections in well-defined groups would be the most efficient. The modern aeroplane and its accessories form an extremely complex entity, and without a definite system of grouping the problem of maintenance is liable to be unnecessarily complicated. Correct selection of the groups will tend to ensure that the whole aeroplane is adequately inspected, and reduce considerably the possibility of any points being overlooked. It is also a most important factor in reducing the time taken to do the inspections. By suitable arrangement of the groups and the operations inside each group, in a regular sequence so that they are progressive as the mechanic moves around the aeroplane, the necessity for making several visits to the same part of the aeroplane is obviated. Moreover, it should be possible to employ a number of mechanics of the same or different trades to do inspections at the same time, with the minimum risk of interfering with one another, again offering a reduction in the length of time necessary to do the inspection. Reference to the specimen schedule will show how these points have been considered in building it up.

The complexity of the modern engine installation, providing as it does a source of power for various electrical, hydraulic and pneumatic services used to operate the airframe components such as retractable undercarriages and flaps, renders it difficult to separate the engine schedule from that of the airframe. It is not easy to say where one ends and the other begins. In practice, however, it will be found that separate schedules can be drawn up. The same principle applies to a lesser degree to wireless or any other special equipment which may be fitted to the aeroplane. Possibly the most satisfactory way of dealing with this difficulty is to make the primary division of the inspection according to the trade classification of the inspectional staff employed, *i.e.*, to make fitter and rigger schedules rather than airframe and engine schedules. It may then be possible to subdivide the aeroplane into the following inspectional groups to provide a convenient and practical arrangement :—

Airscrew.
Power plant.
Undercarriage.
Cockpit and cabins.
Fuselage or hull.
Tail unit.
Main planes.

This method has been used in the specimen schedule and, although strictly the trade of rigger only should be dealt with in this article, the entire aeroplane has been covered to give a better idea of the complete system.

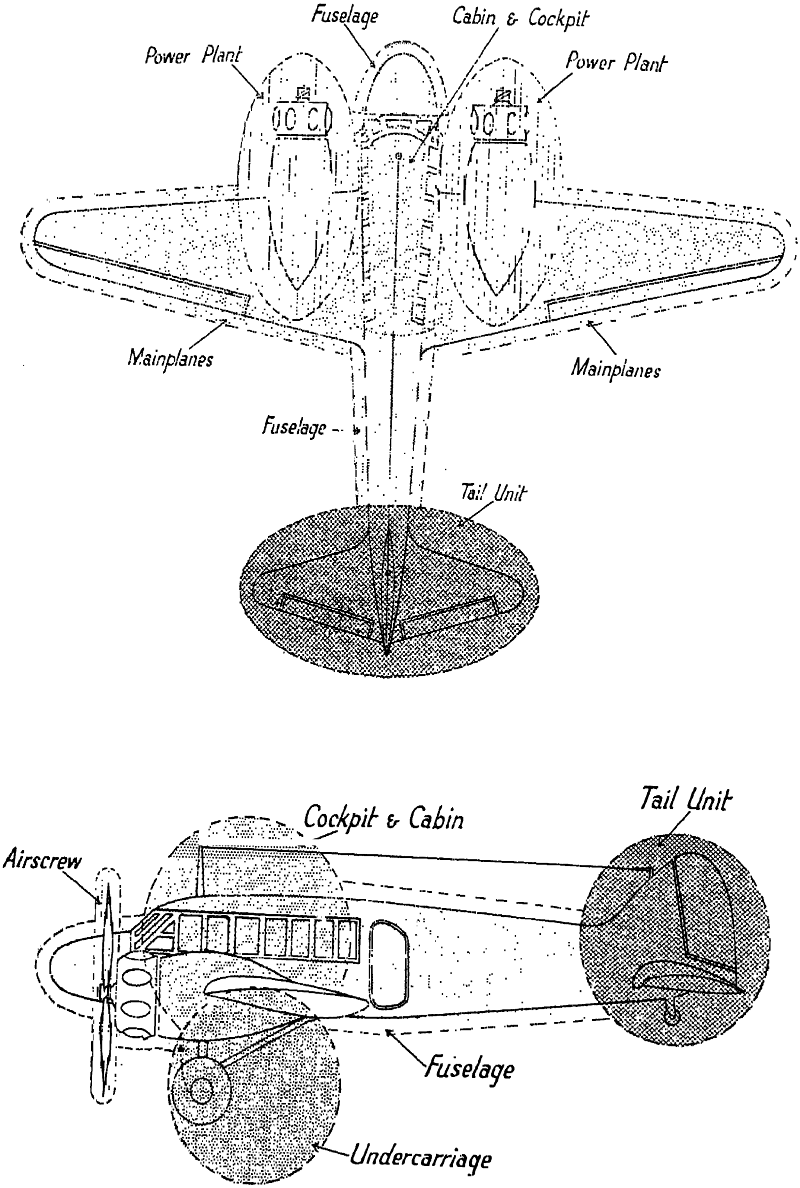


Fig. 12.—PARTS OF AEROPLANE GROUPED TO SIMPLIFY INSPECTION.

Showing the various inspectional groups: power plant, airscrew, fuselage, cabin and cockpit, main planes, undercarriage and tail unit.

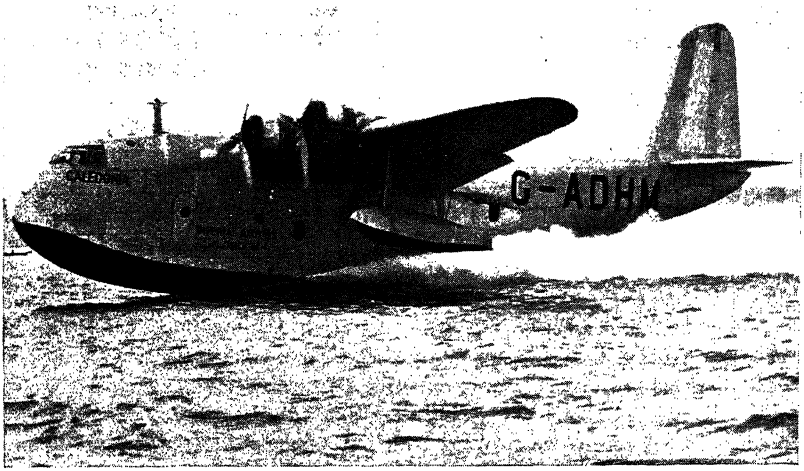


Fig. 13.—Long range four-engined flying boat.

Preparation of the Schedules

14. It is now possible to examine in more detail the method used in compiling the specimen schedule. The basis is one of flying hours and the grouping as indicated above. Although separate inspection regulations may be compiled to govern the application of the schedules, it is usual to repeat the main essentials in a short preamble to each schedule; something on the following lines is all that should be necessary :—

(i) This schedule describes the technical detail of routine inspections necessary in normal circumstances. It does not absolve the inspectional staff concerned from doing any additional work which may be necessary.

(ii) The details of the inspections are given in progressive form and

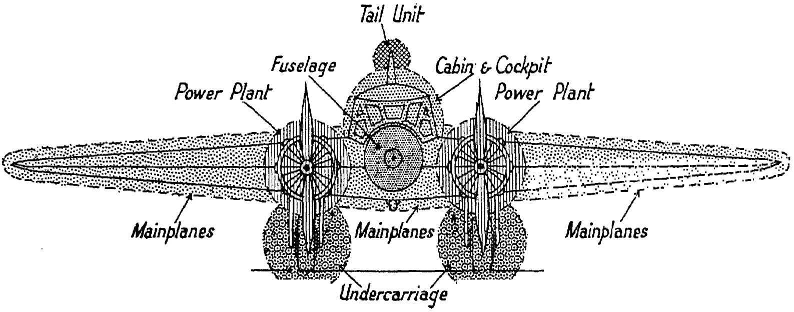


Fig. 14.—Parts of aeroplane grouped to simplify problem of inspection.

for any particular period the complete inspections will be obtained by adding the detail for all the shorter periods.

(iii) The sequence of operations should be followed as far as is possible and the appropriate engineer is responsible that no operation is missed.

(iv) Every effort should be made to do the inspections at the times stated. Any latitude in these times will be for emergency use only.

(v) The schedule may be amended by deleting or adding individual items. Amendments may be made locally as the result of experience or to meet local conditions, but all schedules should be co-ordinated as far as possible.

The technical information for compiling the original schedules is obtained in the first instance from the designers and manufacturers of the aeroplane but experience of similar types previously in use should be taken into account. The peculiar characteristics of the aeroplane and any special equipment with which it may be fitted must be taken into consideration in conjunction with the following factors :—

(i) The necessity for each operation.
(ii) The most suitable tradesmen for the work.
(iii) The appropriate aeroplane group.
(iv) The sequence of operations that will lead to the most efficient work.
(v) The ability to perform the operations with the standard tools and appliances which are available.

Every entry in the schedule should show clearly what defects are to be looked for and the particular points at which defects are most likely to occur. An indeterminate entry, such as, for example, "inspect the aileron controls," is useless. On most types of aeroplanes the aileron controls are not readily accessible and a considerable waste of time may occur in tracing them and examining them in detail when possibly inspection at two or three points would suffice. A study of the manner in which this inspection has been covered will serve to illustrate these points.

The first step is to determine what can go wrong with the controls. The most likely troubles are, lack of lubrication, wear of working parts, fraying of the cables and looseness or insecurity of attachment points. Attention should, therefore, be directed to these. Next, the points on the controls at which these faults may occur. The parts requiring lubrication are listed by the designer or manufacturer, and a simple description of their position should be given. Wear and fraying are most likely to occur in fairleads or in the vicinity of pulleys. The position of these should be defined and also the position of the attachment points.

The next stage is to determine the interval or periods between which inspection of each part is necessary. Experience has shown that this

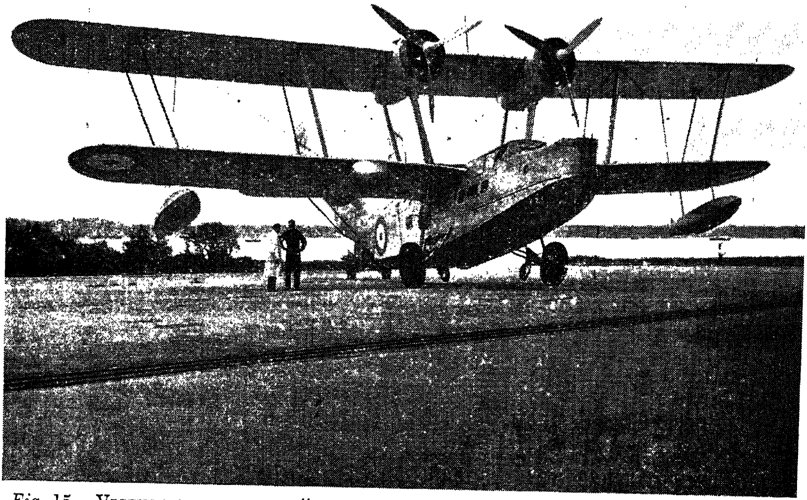


Fig. 15.—VICKERS SUPERMARINE " STRANRAER " TWIN-ENGINED FLYING BOAT FOR RECONNAISSANCE AND BOMBING.

Fitted with Bristol " Pegasus " engine.

k on the various types illustrated in this article will be

varies for each point and that the inspections can be spread therefore over the 10, 20 or 40 hour periods according to their importance. Finally, it is necessary to ensure that the inspectional operations are allocated to the correct groups, and that the sequence of operations inside each group is arranged so that the work can be done efficiently and with the greatest economy of time and labour.

The aileron controls begin in the cockpit ; this is one of the suggested inspectional groups. They continue and end in the main planes ; another group. The inspection can now be correctly subdivided, and in the schedule becomes :—

INSPECTION EVERY 10 HOURS

Cockpit and Cabin. Inspect for security the aft end of the aileron que shaft and the bolts securing the joint to the spar.

Examine the chains for lubrication.

NOTE. Access is obt

e of tl

Main Planes. Inspect for wear and lubrication of the shackles and s at the aileron levers See that the levers and turnbuckles are secure.

INSPECTION EVERY 20 HOURS

Cockpit and Cabin. Examine the aileron control attachments for security and the pins, turnbuckles and splices for wear and security.

NOTE. Access to the aileron cables is obtained by removing the guard on the rear face of the front spar.

Main Planes. Check the setting of the ailerons and the tension of the aileron control cables.

Inspect the aileron cables for fraying at the pulleys.

INSPECTION EVERY 40 HOURS

Main Planes. Inspect for security the aileron cable pulleys ; examine the ball bearings for slackness and lubricate them.

This is not necessarily complete but sufficient indication has been given to illustrate the general principles employed in building up the complete schedule in which every part of the aeroplane has been treated in a similar manner. If these operations are done correctly they should result in a systematic inspection of the vital points of the controls spread over a period which makes the work practical, efficient and economic. All unnecessary work is eliminated but, at the same time, the correct functioning of the controls is reasonably assured.

It is sometimes necessary to include in the schedule a few general clauses to remind the inspectional staff of their responsibilities, for example, " See that all loose articles are properly stowed," and " See that cowling panels and inspection doors are securely fastened." Such operations are usually included in the " between flight " and " daily " inspections only and it is suggested that they should be confined to these periods and limited in number as far as possible. Those found in the specimen schedule have been included as the result of considerable experience to cover points which may be overlooked and, if so, may result at least in the inconvenience of the occupants, if with no more serious consequences.

INSPECTION SCHEDULES

By Squadron-Leader K. L. Boswell, A.F.R.Ae.S.

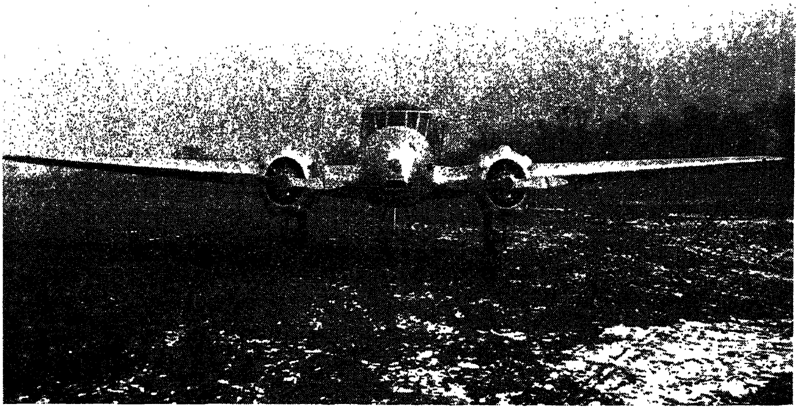


Fig. 1.—An "Avro" "Anson" ready for inspection.

The specimen schedule of inspections given in this article is suitable for a monoplane of this type.

Specimen Schedule of Inspections

In order to compile a specimen schedule of inspections certain assumptions have been made. It is assumed, for example, that the aeroplane is a typical modern low wing monoplane, with steel tubular fuselage, wooden box spar wings covered with ply, and a retractable undercarriage. Its all-up top weight is considered as in the neighbourhood of 7,000 lbs. The schedule would be issued for guidance only and would be subject to amendment or alteration as the result of experience. It has been subdivided under four trades, rigger, fitter, instrument maker and wireless mechanic. As previously suggested, the schedule should be headed by a short preamble on the responsibilities of the mechanics.

RIGGER

Inspection Between Flights

1. See pilot's report.

2. Inspect the undercarriage for damage and see that the pressure in the compression struts and tyres appears normal.

3. Examine the tail wheel for damage and see that the pressure in the tyre appears normal.

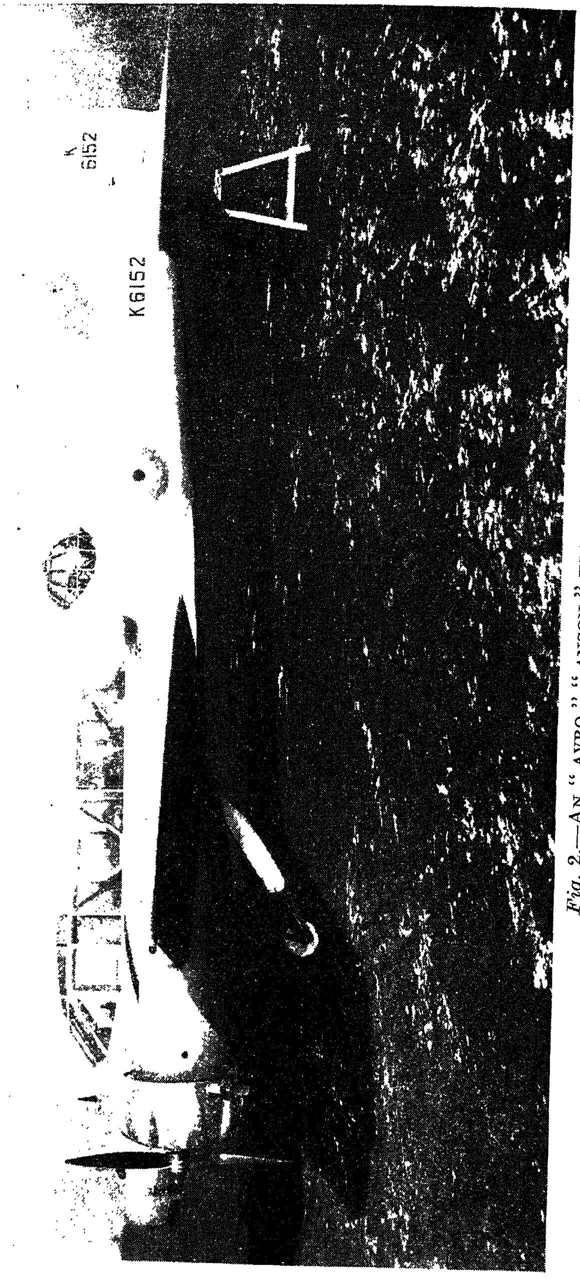


Fig. 2.—An "Avro" "Anson" in rigging position.

4. Check the pressure in the compressed air container for the wheel brakes.

NOTE.—The pressure should be at least 130 lbs. per square inch as shown on the indicator gauge on the pilot's instrument board.

5. Examine the safety pins of the pilot's safety belt for distortion and security.

6. See that all loose articles are properly stowed.

7. Report to the pilot before he takes off.

NOTE.—The details of this inspection need not be recorded.

Inspection Daily

NOTES.—(i) See pilot's reports.
(ii) Details of the aeroplane and the lubricants to be used are given in the maker's handbook.

Undercarriage

1. See that the wheels are properly secured and the axle joints clean.

2. See that the pressure in the tyres appears normal and examine the tyres for cuts and other damage.

3. See that the length of the sliding portion of the compression struts appears normal and check the pressure by the special indication gauge.

NOTE.—Loss of pressure will be indicated by excessive wrinkling of the leather stocking.

4. See that the undercarriage attachments are secure and not damaged.

Cockpit and Cabin

1. Operate the elevator and aileron controls and see that full and free travel is obtainable.

2. Operate the rudder controls and see that full and free travel is obtainable.

3. Check the action of the elevator and rudder trimming controls and see that they move freely.

4. Inspect the pilot's safety belt and its anchorages for security.

5. See that the fire extinguishers are securely stowed.

NOTE.—One is fitted to the right of the pilot's seat and the other forward of the cabin door.

6. Check the pressure in the wheel brake and container by the triple indicator gauge on the pilot's instrument board and replenish as necessary.

NOTE.—The pressure should not be below 130 lbs. per square inch and the maximum pressure is 210 lbs. per square inch.

7. See that the sliding window panels operate freely and that the catches fasten correctly. See that the windows are clean and not cracked.

8. Examine the starboard door for security and the catch for correct fastening.

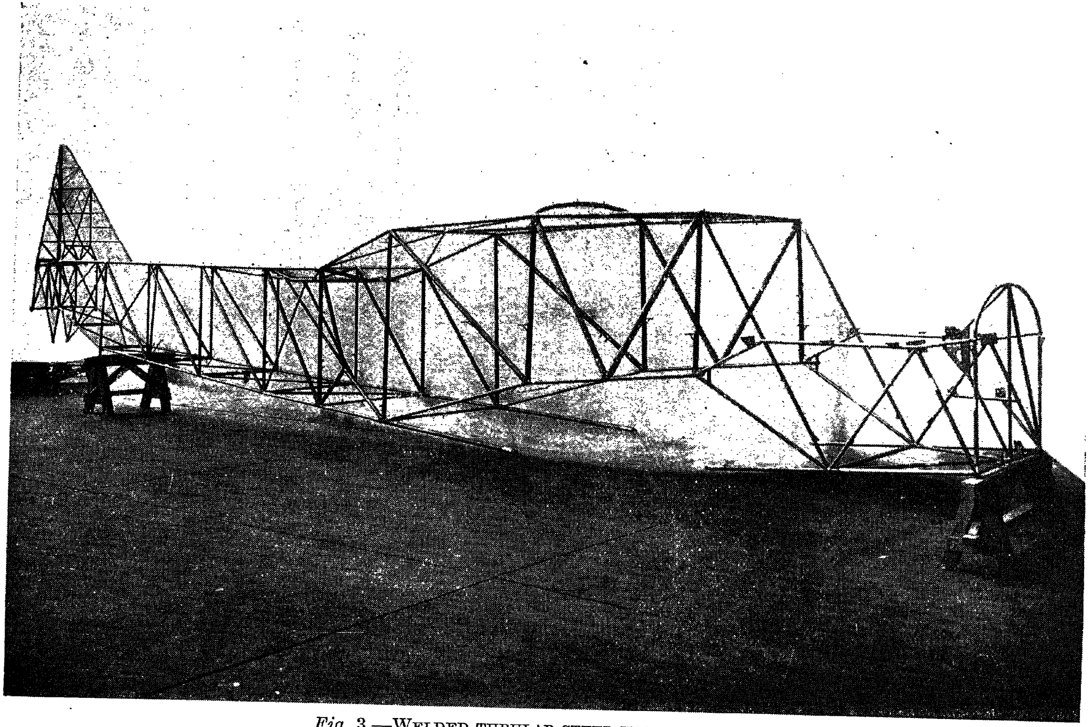


Fig. 3.—WELDED TUBULAR STEEL FUSELAGE FRAME.

This is as used on the "Avro" "Anson." Longerons, fuselage struts and fittings are inspected for damage or corrosion every 20-hour inspection (see p. 72).

Fuselage

1. See that the covering and lacing are undamaged and that the main plane and tail fillets are secure.

Tail Unit

1. Inspect the tail plane, fin, rudder, elevator and trimmers for damage.
2. See that the tail wheel is properly secured and the fittings undamaged.
3. See that the pressure in the tail wheel tyre appears normal and examine the tyre for cuts or other damage.

Main Planes

1. Inspect the covering of the main planes and ailerons for damage, particularly on the lower surface in the airscrew slipstream.

General

1. See that all cowling panels and inspection doors are undamaged and securely fastened.
2. Make the necessary entries on the inspection form.

Inspection Every 10 hours

Undercarriage

1. See that the axle forks are not damaged and lubricate the compression strut and radius rod bottom bearings.
2. Inspect the bolts at the top ends of the radius rods and see that they are locked ; lubricate if necessary.
3. See that the radius rod fairings are properly secured.
4. Inspect for slackness the chains of the retracting gear and lubricate if necessary.
5. Lubricate the pivot bearings of the release levers.

Cockpit and Cabin

1. Lubricate the control wheel spindle bearing.
2. Inspect for security and lubricate the teeth of the pinions interconnecting the rudder pedal torque shafts and the pins securing the cables.

   NOTE.—The rudder pedal torque shafts are at the back of the instrument board.
3. Inspect for security the undercarriage retracting gear handle. Lubricate the bearing of the winding handle.

   NOTE.—Access to the bearing is obtained by removing the cushion of the pilot's seat.
4. Lubricate the bevel gears and the clutch faces of the undercarriage retracting gear.
5. Inspect for security the aft end of the aileron torque shaft and the bolts securing the joint to the spar. Lubricate the chains.

NOTE.—Access is obtained through the door on the guard on the main cross member.

Fuselage

NOTE.—For inspections 1–8 enumerated below it will be necessary to remove the detachable panel under the pilot's cockpit floor.

1. Inspect the control-column and the attachment of its fulcrum brackets to the floor for security.
2. Inspect for security and lubricate the universal joint pin at the bottom end of the control-column.
3. Inspect for security and lubricate the pin securing the front end of the aileron torque shaft to the control-column.
4. Inspect for security the pins securing both ends of the elevator connecting rod.
5. Inspect for security the bolts securing the elevator lever on the bottom face of the front spar and lubricate the shackle pin.
6. Inspect for security the front pulleys of the rudder cable controls.
7. Inspect for security the rudder cable pulleys aft of the front spar and under the floor.
8. Inspect for security the bottom end of the countershaft of the retracting undercarriage gear.
9. Inspect for security and lubricate the elevator rocking lever bearing, pins and shackles, on the underside of the front spar.

Tail Unit

1. Inspect for security and lubricate the elevator rocking lever bearing, pins and shackles at the tail end of the fuselage.
2. Inspect for security and lubricate the pins at the top and bottom of the tail wheel shock absorber strut.
3. Lubricate the tail wheel rocking beam at all three points.
4. Inspect for security, at both ends, the elevator connecting rod at the rear end of the fuselage.
5. Inspect for security and lubricate the pins securing the rudder cables to the rudder quadrant.
6. Inspect the attachments of the rudder cable pulleys for security.
7. Inspect for security and fractures the attachment fittings of the tail plane to the fuselage.

Main Planes

1. Inspect for wear and lubricate the shackles and pins at the aileron levers ; see that the levers and turnbuckles are secure.

Inspection Every 20 hours

Undercarriage

1. Lubricate the undercarriage retracting frame countershaft bearings.

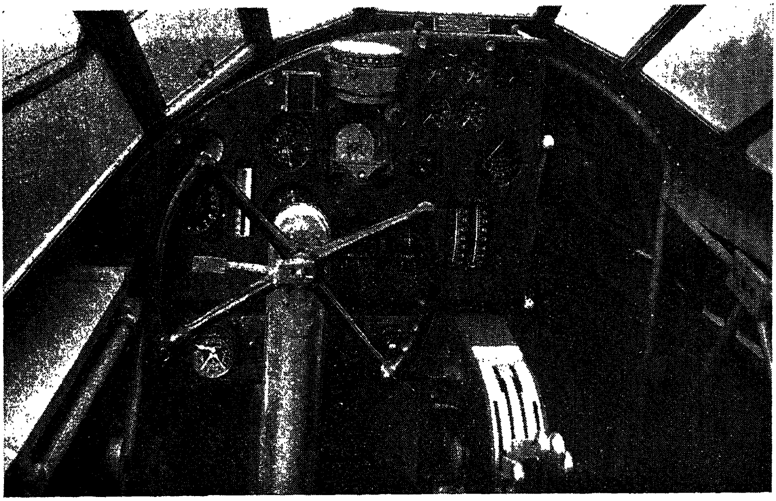


Fig. 4.—CONTROL COLUMN INSPECTION.

Showing the pilot's cabin in the "Avro" "Anson." For inspection of the control column and adjacent controls, it is necessary to remove the detachable panel under the floor (see p. 70).

2. Lubricate the compression strut top bearings.

3. Check the pressure in the compression struts by gauge.

NOTE.—The correct pressure is 470 lbs. per square inch.

4. Lubricate the gland packing compression struts.

5. Check the pressure in the tyres by gauge.

NOTE.—The correct pressure is 35 lbs. per square inch.

6. Test the brakes for accurate operation and make sure that the blocks are not rubbing when the brake lever is released.

NOTE.—With the brake hand lever pulled upwards three notches in the quadrant the indicator on the dashboard should show the same pressure in each wheel. With the hand lever hard on and the rudder central both wheels should be locked.

7. Inspect the undercarriage locking control bowden cable and springs for wear, fractures and security. Lubricate the pins.

8. See that the bowden cables operating the undercarriage locking device are correctly adjusted so as to ensure that when the control lever in the cockpit is raised the lock on the undercarriage frame is released.

NOTE.—Access to the cable adjustment turnbuckle is obtained through the inspection door located on the outside of the fuselage.

Cockpit and Cabin

1. Inspect the cable splices, pins, turnbuckles and shackles for wear, damage and security and lubricate the pins for the following cables :—

(i) The rudder trimming control cables from the front side of the cabin roof;

(ii) The elevator trimming control cables from the starboard side of engine control unit.

2. Lubricate sparingly the sprocket chain and bearing for the rudder trimming control on the cabin roof.

3. Examine the aileron and rudder control cable attachments for security of the splices, pins, turnbuckles and shackles for wear, damage and security.

NOTE.—Access to the aileron control cables is obtained by removing the guard on the main cross member.

4. Inspect the brake relay valve and pipe line for leaks. Inspect for security and lubricate the pins and fork ends on the connecting rod between the brake relay valve and the rudder pedals.

NOTE.—To avoid damage to the relay valve care must be taken to adjust the length of the connecting rod so that the rudder pedal hits the floor stop before the lever on the relay valve reaches its maximum movement.

Fuselage

1. Examine for wear and security the elevator cables at the connections to the lever on the bottom face of the front spar.

NOTE.—Remove the detachable panel under the pilot's floor for this inspection.

2. Inspect the control cables inside the fuselage for fraying, at the portions that bear on fairleads or pulleys for rudder cables, elevator cables, rudder trimming control cables, elevator trimming control cables.

NOTE.—Access is obtained by removing the detachable panels under the floor.

3. Inspect the longerons, fuselage struts and fittings for damage or corrosion.

4. Examine the aerial mast for damage and security.

5. Examine the control cables for corrosion and fraying where they pass through the fabric coverings.

Tail Unit

1. Remove the detachable panels and inspect the cable splices, turnbuckles and shackles for fraying, security and wear.

NOTE.—The following are the cables concerned :—

Elevator cables at the rear rocking lever.
Rudder cables at the attachment to the quadrant at the bottom of the rudder.
Elevator trimming control cables.
Rudder trimming control cables.

2. Inspect for damage and lubricate all bearings and pins for the rudder and elevator trimming controls at the rear end of the fuselage.

3. Inspect for damage and lubricate all bearings and pins for the rudder and elevator trimming controls at the rear end of the fuselage.

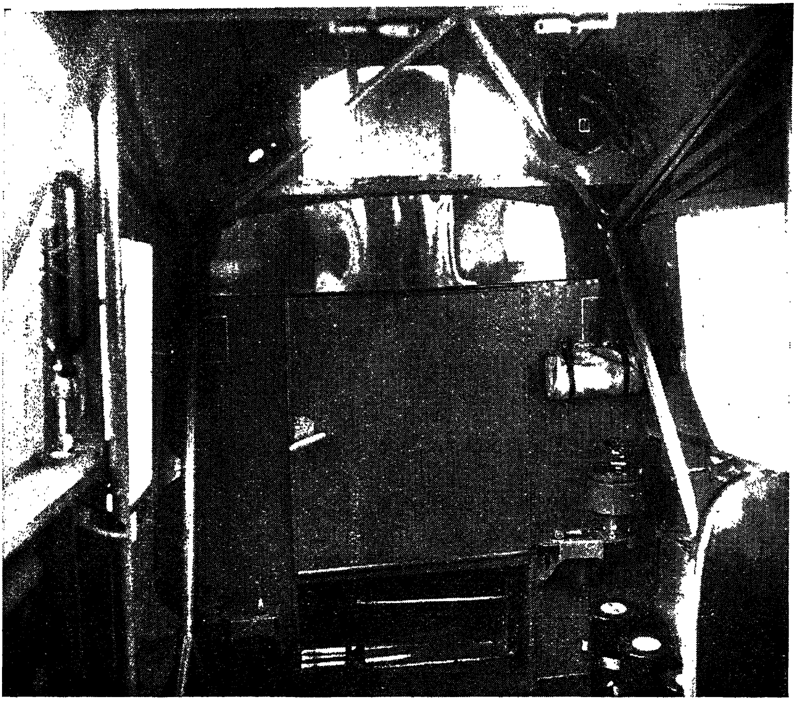


Fig. 5.—RIGGER'S INSPECTION BETWEEN FLIGHTS.

See that all loose articles are properly stowed. The above picture shows cabin interior of " Avro " " Anson." Note the entrance door to rear gun turret.

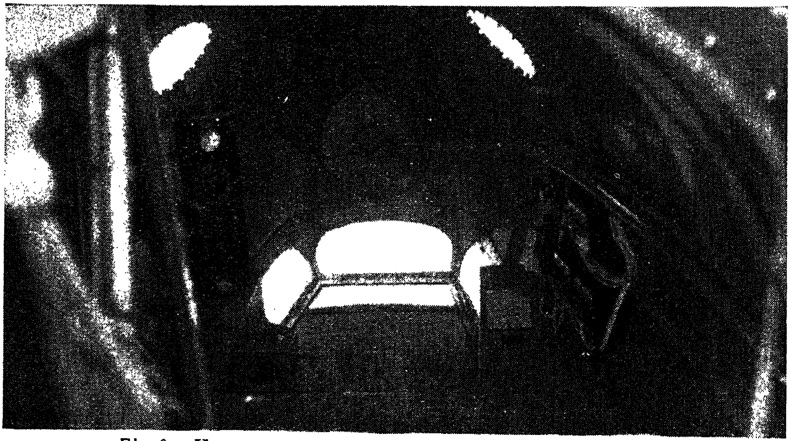


Fig. 6.—VIEW FROM INTERIOR OF CABIN (" AVRO " " ANSON ").

4. Lubricate the hinges of the rudder and elevator trimmers.

5. Check the pressure in the tail wheel tyre by gauge.

NOTE.—The correct pressure is 35 lbs. per square inch.

6. Examine the tail wheel centralising spring for damage and lubricate the shackle pin.

7. Inspect for security the top attachment of the tail wheel shock absorbing strut to the fuselage. Inspect the pins at the top of the strut for wear.

NOTE.—Access is obtained through the tear-off patch port side of the fuselage under the fin.

8. See that the fin is securely attached.

9. Examine the control cables for corrosion and fraying where they pass through the fabric coverings.

Main Planes

1. Check the setting of the ailerons and the tension of the aileron cables.

2. Inspect the aileron cables for fraying at the pulleys.

3. Inspect the engine nacelle struts and fittings at the points of attachment to the spar for cracks or damage.

NOTE.—Access to these points is obtained by removing rear inspection panel.

Inspection Every 40 hours

Undercarriage

1. Remove the wheels and inspect the axles for damage or wear.

2. See that the brake blocks are clean and free from oil.

3. Examine the brake linings for wear and cracks and the drums for scoring.

4. See that there is no excessive slackness of wheels on axles. Check that there is no side play on the wheels.

5. Examine for defects and lubricate the ball bearings. See that wheels are replaced securely

6. Check the chains of the undercarriage gear for stretch. Inspect for slackness and lubricate the ball races on the vertical countershafts.

7. Inspect the axle fork on the radius rod for cracks and fractures, particularly at the welds.

Cockpit and Cabin

1. Examine for stretch the chain of the rudder trimming controls on the cabin roof.

2. Check the action of the clutch on the undercarriage winding handle.

3. Inspect for security the hand lever for the undercarriage release gear. Lubricate the plunger at the top of the handle and the bearing at the bottom.

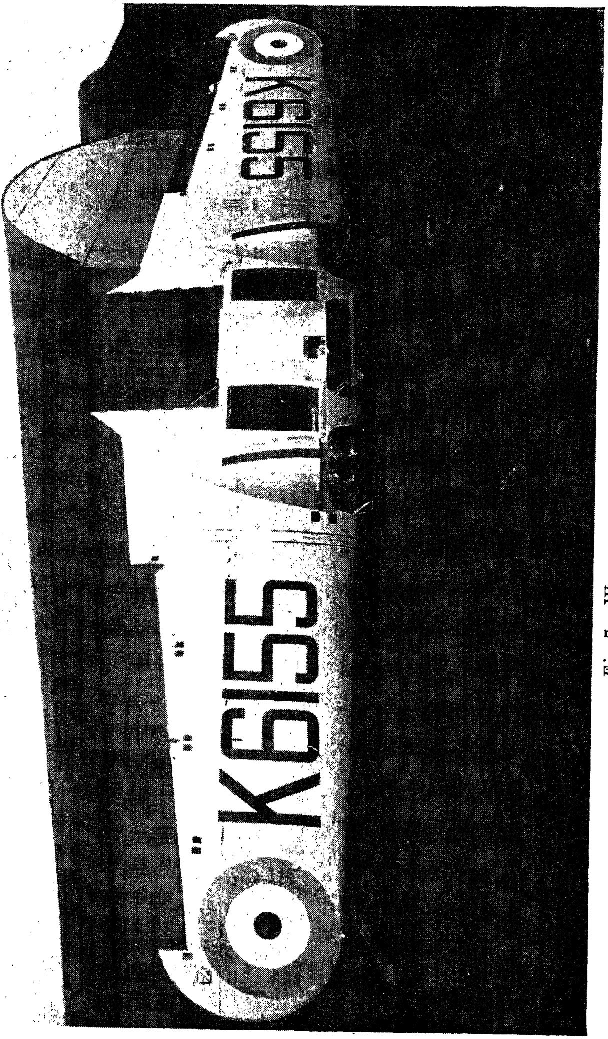


Fig. 7.—Wing on transport bogie.

The above shows the wing of an “ Avro ” “ Anson ” twin-engined monoplane.

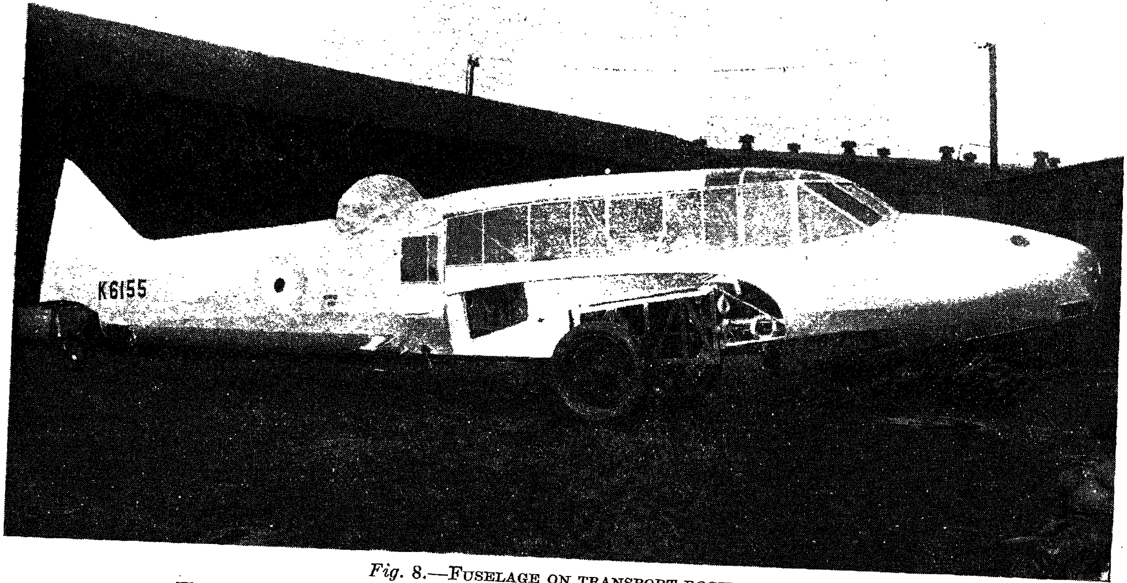


Fig. 8.—FUSELAGE ON TRANSPORT BOGIE.
The fuselage of an " Avro " " Anson " twin-engined low-wing monoplane is shown.

4. Check for axial play and lubricate the controls for the undercarriage warning device.

Fuselage

1. Inspect the dural plating of the nose for damage and corrosion. Examine the bolts and attachment fittings to the centre portion for security.

2. Remove the control-column chain guard; inspect the chain for stretch and lubricate as necessary.

3. Inspect for slackness and lubricate the ball bearings at the bottom pivot of the control-column.

4. Inspect for slackness and lubricate the ball bearings at the attachment of the control-column to the fulcrum brackets. Examine the brackets for security and fractures.

5. Inspect for slackness and lubricate the ball bearings at both ends of the aileron torque shaft.

NOTE.—Open the inspection door in the guard on the front main cross member for access to rear end bearing.

6. Inspect for slackness and lubricate the ball bearings at both ends of the elevator connecting shaft.

7. Inspect for slackness and lubricate the ball bearings for the elevator lever on the front cross member.

8. Inspect for slackness and lubricate the ball bearings in the front pulleys for the rudder cable controls.

9. Inspect for slackness and lubricate the rudder cable pulleys rear of the front main cross member under the floor.

10. Examine all removable and sliding panels; see that they are not damaged and the catches lock correctly. Lubricate as necessary.

11. See that all emergency exits are undamaged and secure.

Tail Unit

1. Remove the tail wheel and inspect the axle for damage; see that there is no excessive play of the wheel on the axle.

2. Examine for defects and lubricate the ball bearings in the tail wheel. See that the wheel is replaced securely.

3. Inspect for security and slackness the ball bearing hinges on the elevator and rudder. Lubricate as necessary.

4. Inspect for slackness and lubricate the ball bearings at both ends of the elevator connecting rod.

5. Inspect for slackness and lubricate the elevator and rudder cable pulleys at the rear end of the fuselage.

6. Inspect for security and lubricate the elevator trimmer turnbuckle and the oiling pad round the cable drum.

NOTE.—Access is obtained through the inspection door on the underside of the fairing.

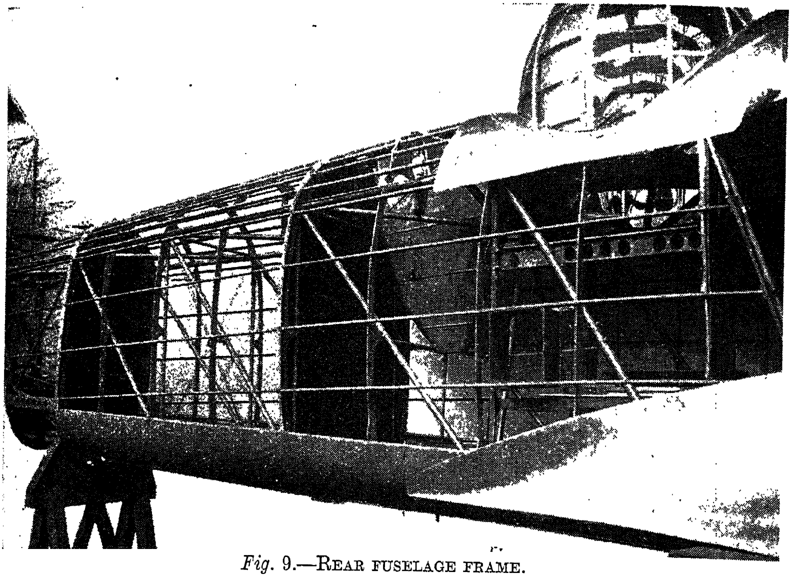


Fig. 9.—REAR FUSELAGE FRAME.

Note fabric covering stripped for examination (see p. 80).

7. Inspect for security and lubricate the rudder trimmer turnbuckle.

NOTE.—Access is obtained through the inspection door on the port side of the fin.

8. Inspect for security and lubricate the trimmer pulleys in the tail plane, fin and end of fuselage.

Main Planes

1. Inspect the engine mountings for damage and the bolts, struts, and attachment fittings for corrosion and security.

NOTE.—The cowling must be removed.

2. Inspect the attachment fittings of the fuel tanks for fractures, corrosion and security.

3. Inspect for security the aileron cable pulleys. Examine the ball bearings for slackness and lubricate.

4. Examine for slackness and lubricate the ball bearing hinges on the ailerons.

5. Inspect the main planes and ailerons externally for signs of internal damage.

6. Inspect the four points of attachment of the wing to the fuselage for damage, corrosion and security.

Inspection Every 120 hours

Undercarriage

1. Drain the gearboxes of the retracting gear and refill with new oil.

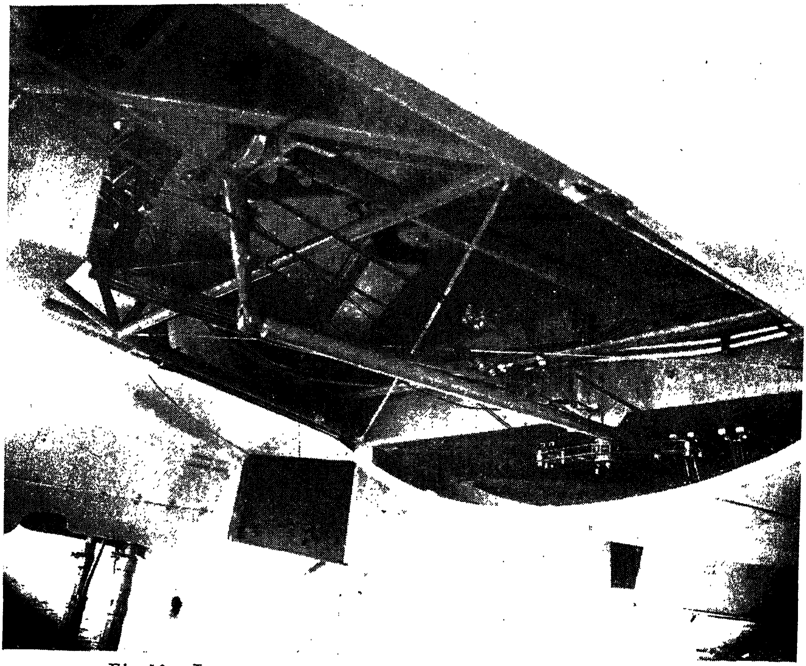


Fig. 10.—INSPECTION OF CONTROL CABLES INSIDE FUSELAGE.
Access is obtained by removing the detachable panels under the cabin floor, as shown.

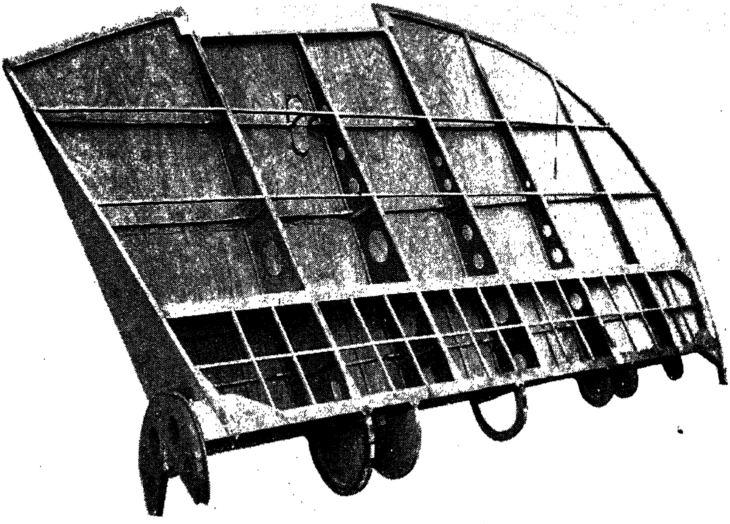


Fig. 11.—INTERIOR OF "AVRO" "ANSON" RUDDER.

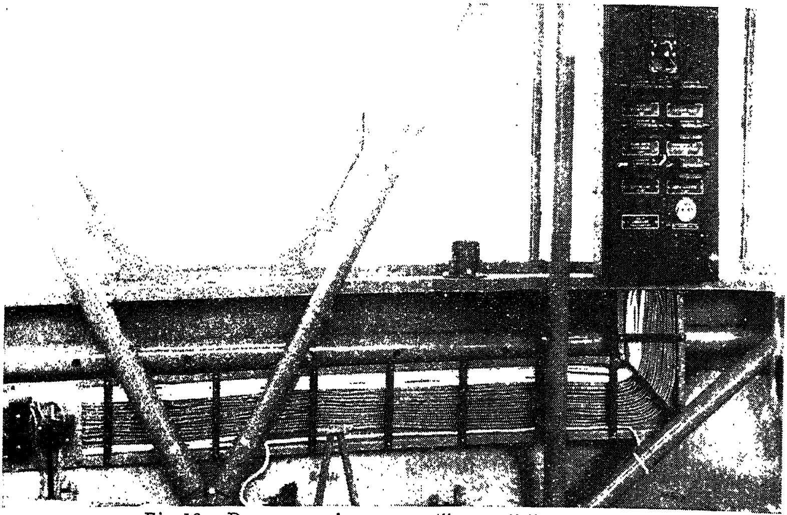


Fig. 12.—BOMB AIMER'S STATION (" AVRO " " ANSON ").
Note the fuse board on the right.

2. Remove and examine for wear the pivot bolts at the top of the compression struts.

Fuselage

1. Fold back the fuselage coverings and inspect all fuselage members for bowing and fittings for security and corrosion.
2. Check the security of the fairing and decking clips on the longerons.
3. Check the tension of bracing wires and the locking of stringers.

NOTE.—Before any adjustments are made the aeroplane must be placed in rigging position.

Tail Unit

1. Open the inspection covers and inspect internally for signs of damage and corrosion.
2. See that all draining eyelets are clear.

Main Planes

1. Open all inspection covers and door and inspect internally for signs of damage and corrosion.
2. See that all draining eyelets are clear.

General

1. Check the rigging of the complete aeroplane.

The next section deals with the inspection schedule as it affects the fitter.

INSPECTION SCHEDULES *(continued)*

FITTER

Inspection Between Flights

NOTE.—The details of this inspection need not be entered on the inspection form.

1. See pilot's report.
2. See that ignition switches are in the " off " position.
3. Inspect the airscrews for damage.
4. Make a general examination of the fuel and oil system for obvious leaks.
5. Replenish fuel and oil tanks, if necessary, and see that the filler caps are properly secured.
6. See that engine nacelle panels are correctly fitted and secure.
7. Report to the pilot before he takes off and state the approximate amount of fuel and oil in the tanks.

Inspection Daily

NOTE.—See any report on the aeroplane inspection form. Details of the engine are given in the maker's handbook.

Airscrew

1. Test by feel on the airscrew that the hub is tight upon the airscrew shaft and that there is no excessive backlash or thrust movement.

NOTE.—After initial attachment an airscrew should be examined for tightness and tightened, if necessary, at the end of each of the first two or three flights.

2. Examine the airscrew for damage and deep scratches.

Power Plant

1. Inspect the sparking plugs and cylinder joints for signs of gas leakage.
2. Inspect the exhaust manifolds and support brackets for security.
3. See that all H.T. cables and sparking plug connections are secure.
4. Inspect the magnetos for security and see that the L.T. cables are properly attached.
5. Inspect the pipe lines and unions of the fuel and oil system for security and leaks.

Cockpit and Cabin

1. Test the throttle and mixture controls for freedom of movement.

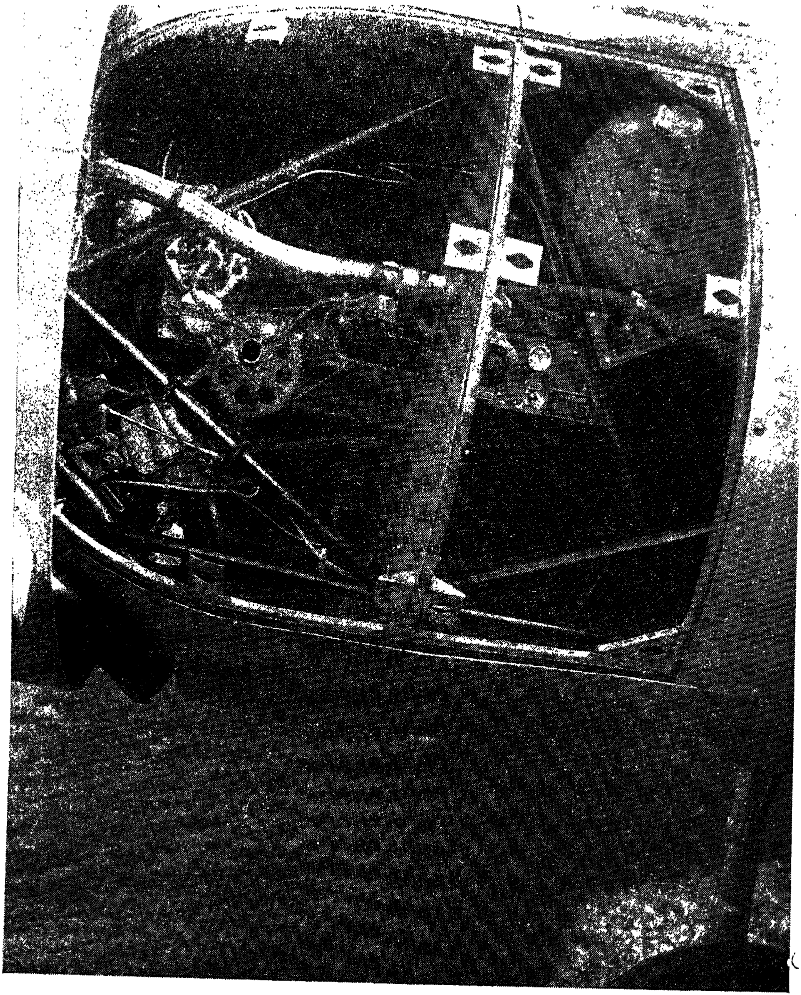


Fig. 13.—ENGINE MOUNTING. (" AVRO " " ANSON.")

Panel removed to show internal arrangement. The engine mounting ring should be inspected for fracture and damage every 20 hours and the bolts of the crankcase and mounting should be inspected for ti

2. See that the fuel cock controls function correctly.

3. Inspect the ignitions switches for correct mechanical functioning and see that they are in the " off " position.

Inspection Every 10 hours

General

1. Remove dirt and surplus oil.
2. See that no tools or rag are left lying on the engine.
3. Inspect the nacelle cowling and engine fairing for security.
4. Make the necessary entries on the inspection form.

Power Plant

1. See that the upper and lower locking rings on the cylinder are tight. Avoid over-tightening the lower ring which may deform the cylinder.

2. Lubricate the valve stems.

3. Inspect the exhaust manifold for excessive burning and cracks.

4. Examine for security the muffs, flexible pipes and control box of the cabin heating system.

5. Examine for security the connecting rods and link work of the throttle and mixture controls ; lubricate the moving joints.

6. Inspect for security and lubricate the bearings of the engine control countershafts.

7. Inspect for security and lubricate the bearings, fork-ends and pins of the fuel cock controls.

8. Remove and clean the fuel filters on the bulkheads.

NOTE.—When filters are dismantled see that gauze is not damaged, and do not use rag for cleaning. Ensure that the filter is locked when re-assembled.

9. Remove and clean the oil scavenge sump filters.

10. Remove and clean the oil pressure filters.

NOTE.—When filters are dismantled see that gauze is not damaged and do not use rag for cleaning. Ensure that the filter is locked when re-assembled.

11. Replenish the oil in the crankcase.

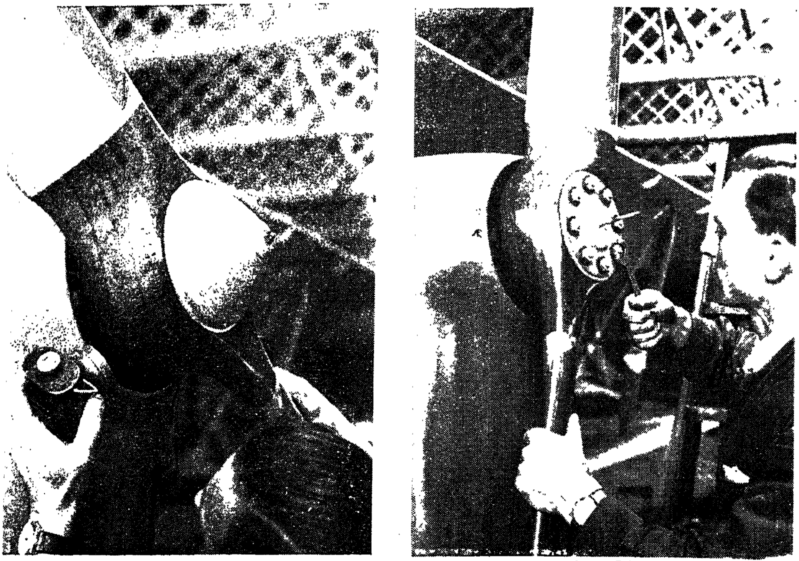
Cockpit and Cabin

1. Examine for security the throttle and mixture controls, link work and connecting rods and lubricate the moving joints.

Main Planes

1. Inspect the fuel tanks and connections for security and leaks. See that vent pipe is clear.

The section which follows deals with suitable routine 20-hour, 40-hour and 120-hour inspections for the fitter.



[*Brooklands Aviation Ltd.*

Fig. 14.—INSPECTION OF AIRSCREW.

Examining condition of blades, boss and sheathing, before checking for track.

Inspection Every 20 hours

Airscrew

1. Remove spinner nose cap and examine the front side of the blade sheet within the blocks for signs of fracture.

Power Plant

1. Inspect the engine mounting ring for fracture and damage and the bolts of the crankcase and mounting for tightness.
2. Dismantle the valve rocker gear and lubricate the push rod both ends.
3. Examine the push rod and return springs for fractures.
4. Examine the valve rocker standards for security.
5. Clean the valve springs and examine for fractures.
6. Re-assemble the valve rocker gear and lubricate the rocker bearings.

NOTE.—The three bearings are lubricated through one nipple.

7. Check the valve clearances with feelers.
8. Check the compression of each cylinder.
9. Lubricate the bearings and chain of the hand turning gear.
10. Inspect the magneto contact breaker springs for deterioration.
11. Check the gap between the magneto contact breaker points; see that the rocker arm is free, the points clean and not pitted.

NOTE.—When doing this see that the rocker arm is riding on the

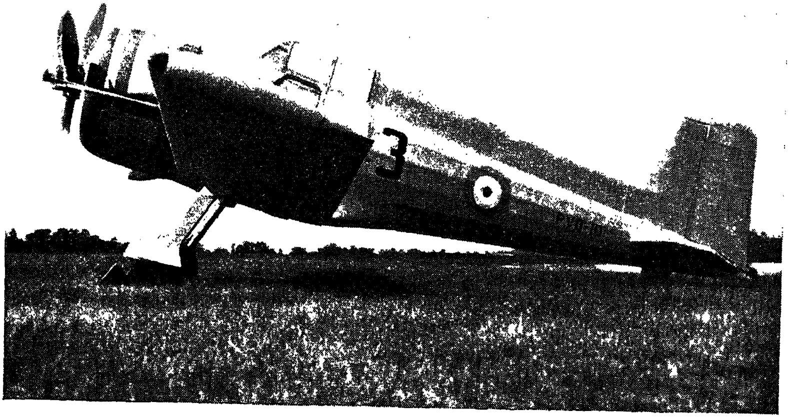


Fig. 15.—VICKERS "VENOM" SINGLE-SEATER LOW WING FIGHTER.

tion schedules for this monoplane would be simi

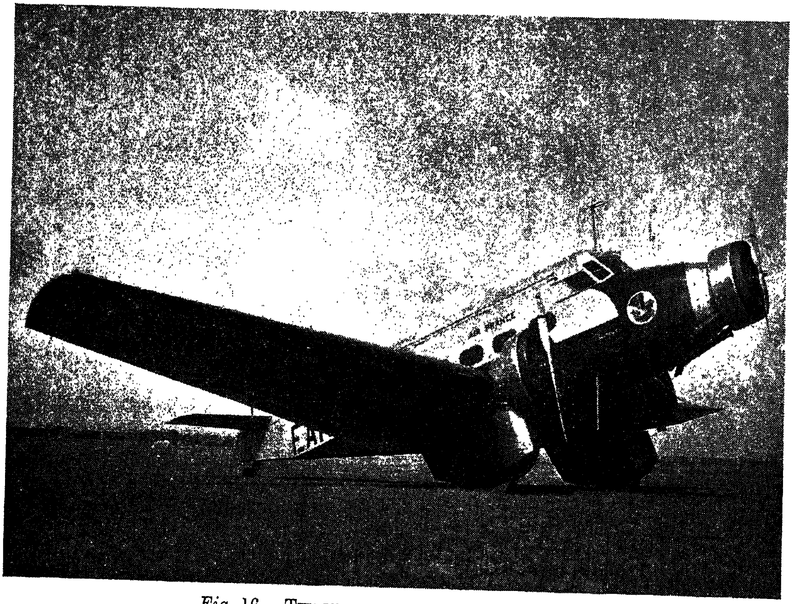


Fig. 16.—THREE-ENGINED WIBAULT MONOPLANE.

hedules to those described would apply in the case of the above highest point of the cam and apply finger pressure to ensure that the contact breaker is home in its housing.

12. Clean the distributor and contact breaker covers and examine the insulation for cracks; see that all connections are tight.

13. See that the distributor segments are not pitted, that the contact breaker cover spring is in good condition and that proper contact is made with the L.T. terminal socket.

14. See that the H.T. cables are secure.

15. Inspect the H.T. and L.T. cables for serviceability.

16. Remove and clean the sparking plugs, reset the gaps and test the plugs at a pressure of 100 lbs. per square inch.

17. Inspect the throttle and mixture controls for wear and for excessive play in the connections ; check the setting of the control levers.

NOTE.—See also Cockpit, 20-hour Inspection, Clause 1.

18. Uncouple the carburetter union and see that the fuel flow is not restricted.

19. Remove the base plugs of the carburetter, flush out the float chambers, clean the jets and examine for corrosion.

20. Inspect the flexible fuel and oil pipes for kinking and damage and see that all connections are secure.

Cockpit and Cabin

1. Inspect the throttle and mixture controls for wear and excessive play in the connections ; check the setting of the hand control levers and lubricate the bearings.

NOTE.—See also Power Plant, 20-hour Inspection, Clause 17.

2. Check the cabin heating controls for correct functioning and security.

Inspection Every 40 hours

Airscrew

1. Remove the airscrew from the hub and the spinner from the airscrew and examine for signs of fracture, both sides and both edges of the blade in the region normally covered by the spinner.

2. Inspect the splines in the hub on the airscrew shaft for wear and [illegible]

3. Inspect for corrosion the front and rear hub centering cones on the airscrew shaft and the hollow flanged plug in the end of the shaft.

Power Plant

1. Inspect the tappet guide studs and nuts for security.

2. Inspect the top of the push rod cover brackets for oil leaks.

3. Examine the inlet and exhaust pipe connections for security.

4. Check the tightness of the nuts securing the heater box to the rear cover, carburetter to heater box and air intake to carburetter. Ensure that all joint washers are seating properly.

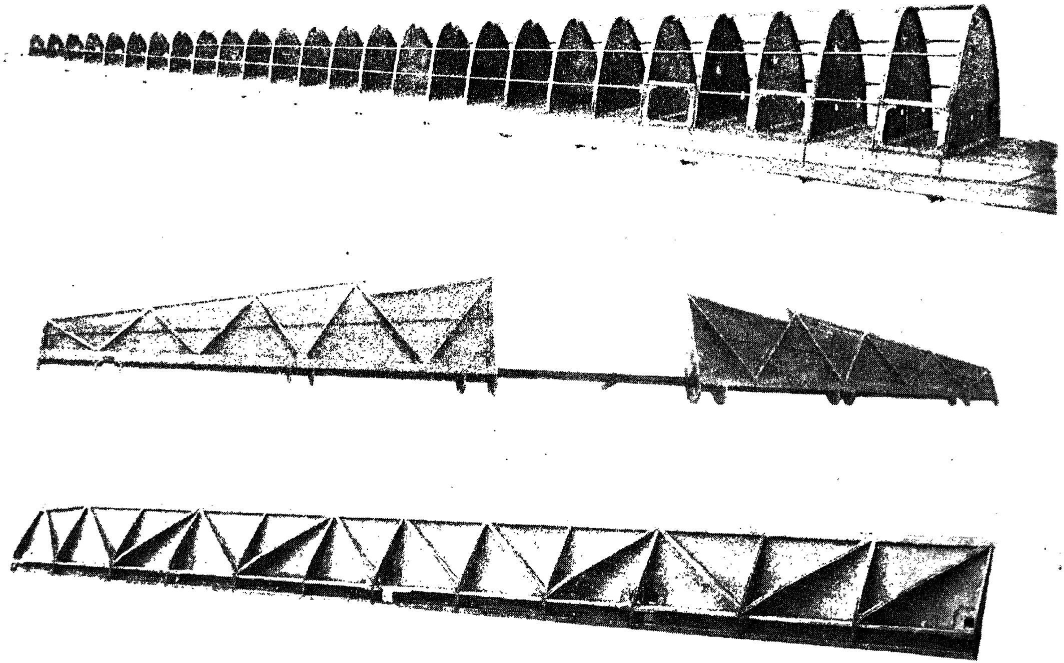


Fig. 17.—Interiors of wing leading edge, elevators and ailerons (" Avro " " Anson ").

External inspection of main planes and ailerons for signs of internal damage is carried out during the rigger's 40-hour inspection.

5. Uncouple the priming pipe connection on the engine and check the flow of fuel from the priming pump, then inspect the pipe lines for leaks.

6. See that the non-return valve on the priming pump functions correctly.

7. Clean the central brush of the magneto. See that the holder is clean and that the brush has free movement.

8. Lubricate the magnetos.

9. Lubricate the felt gland mounted behind the cam of the contact breaker housing.

10. See that all bonding is secure.

11. Inspect for axial play and lubricate the fuel cock controls.

NOTE.—See also Cockpit, 40-hour Inspection, Clause 1.

12. See that the fuel and oil pipes are properly supported and are not touching any part of the structure in a manner likely to cause wear.

13. Drain the oil from the system ; flush the tank and pipe lines and refill with fresh oil.

NOTE.—The tank should be drained when the oil is hot.

Cockpit and Cabin

1. Inspect for axial play and lubricate the fuel cock control.

NOTE.—See also, Power Plant, 40-hour Inspection, Clause 11.

2. Lubricate the bearings of the cabin heating control levers.

Inspection Every 120 hours

Airscrew

1. Dismantle the airscrew, clean the parts and examine for defects.

Power Plant

1. Clean the oil pump relief valve and the relief valve on the top of the crankcase.

2. Check the gap between the brush and the segments of the distributor and see that the vent holes are clear.

3. Check the H.T. and L.T. ignition cables for continuity.

4. Clean the interior of the oil tanks.

NOTE.—The tanks should be removed for cleaning.

5. Examine the flexible fuel and oil pipes internally for resinous deposit.

Main Planes

1. Drain the fuel tanks and clean the interior. Examine the tanks and fittings for corrosion and damage.

NOTE.—See also in Instrument Maker, 120-hour Inspection, Main Planes, Clause 1, and in Wireless Mechanic, 120-hour Inspection, Main Planes, Clause 1.

INSTRUMENT MAKER

Note.—When an instrument maker is not available the following inspections should be allocated to the rigger and/or fitter.

Inspection Daily

Note.—See Pilot's report.

Cockpit and Cabin

(1st pilot's position.)

1. Wind the watch and set to the correct time.
2. Examine the altimeter for security, damaged pointer and for flecking of luminous paint. Check the zero setting of the scale.
3. See that the compass is reasonably free from pivot friction. Inspect the bowl for bubbles and the mounting for security. Clean the mirror.
4. See that the compass deviation card is legible and secure.
5. Check the readings of the boost gauges against the barometric pressure and inspect for visible defects and security.
6. Test the fuel contents gauge for correct functioning and inspect for visible defects and security.
7. Inspect the following for visible defects and security :—

Air speed indicator.
Fore and aft level.
Turning indicator.
Brake pressure gauge.
Oil temperature gauges.
Engine speed indicator.

(2nd pilot's or navigator's position.)

8. Wind the watch and set to the correct time.
9. Examine the altimeter for security, damaged pointer and for flecking of luminous paint. Check the zero setting of the scale.
10. Inspect the air speed indicator for visible defects and security.
11. See that the compass is reasonably free from pivot friction. Inspect the bowl for bubbles and the mounting for security.
12. See that the compass deviation cards are legible and secure.

Fuselage

1. Inspect the venturi of the turning indicator for security, damage and correct alignment in the air stream.

General

1. Make the necessary entries on the inspection form.
2. Clean all instrument cover glasses as necessary.

Inspection Every 20 hours

Power Plant

1. Inspect the generators for the engine speed indicators for damage and see that all connections are secure.

2. Inspect the pipe lines of the oil temperature and oil pressure gauges for kinks, dents and security.

Cockpit and Cabin

1. Examine the pipe lines or capillary tubing for kinks, dents and security for the following :—

Air speed indicator.
Altimeter.
Turning indicator.
Brake pressure gauge.
Oil temperature gauge.
Oil pressure gauge.
Boost gauge.

2. Clean the filter over the air jet of the turning indicator.

3. See that the covers of the compass corrector boxes are properly secured.

4. Inspect the pipe line from the venturi of the turning indicator for dents ; see that the venturi is clear and that the small holes in the tube are not obstructed.

Inspection Every 40 hours

Cockpit and Cabin

1. Inspect the compasses for broken or damaged damping wires and discoloration of the card, bowl, liquid and window ; see that the anti-vibration devices function correctly.

Inspection Every 120 hours

Power Plant

1. Examine for defects and lubricate the flexible drive for the generator of the engine speed indicator.

Cockpit and Cabin

(1st pilot's position.)

1. Inspect the watch holder for security.
2. Remove the altimeter for calibration and test.
3. Calibrate and test the air speed indicator.
4. Remove the boost gauges for calibration and test. Clean the air filter and see that the bore of the pipe line is clear.
5. Calibrate the fuel contents gauge.
6. Remove the turning indicator for calibration and test.
7. Prepare the oil temperature gauges for calibration and test.
8. Prepare the oil pressure gauges for calibration and test.
9. Examine the electrical connections of the engine speed indicator for security.
10. Remove the brake pressure indicator gauge for calibration and test.

(2nd pilot's or navigator's position.)

11. Inspect the watch holder for security.

12. Remove the altimeter for calibration and test.
13. Calibrate and test the air speed indicator.

Main Planes

1. Inspect the fuel contents gauge tank unit for security, damage and correct functioning.

WIRELESS MECHANIC

NOTE.—The inspections should be made in conjunction with instructions in the *Wireless Handbook* of the set installed. Reference should also be made to the appropriate electrical and wireless diagrams for the aeroplane.

Inspection Between Flights

NOTE.—The details of this inspection need not be entered on the inspection form.

1. See pilot's report.
2. Inspect the accumulators for signs of overcharging and leakage of the electrolyte.
3. Examine the last 20 ft. of the trailing aerial for cleanliness and fraying, and the weight attachment for security.
4. Report to the pilot before he takes off.

Inspection Daily

NOTE.—See pilot's report.

Power Plant

1. Examine the engine-driven generator mounting and air-cooling pipes for security.
2. Examine the cable connections to the engine-driven generator for cleanliness and security.

Cockpit and Cabin

1. Examine the voltmeters and ammeters for security and serviceability.
2. Test the voltage of the accumulators on load and examine for leakage of the electrolyte.
3. Test the voltage of the dry batteries and inspect the connections for security and cleanliness.
4. Inspect the wireless crate and its contents for security of mounting.
5. Inspect the aerial winch, bonding, fairlead and attachments for cleanliness and security.
6. Clean the plunger block on the aerial winch. Inspect the other parts of the winch for security and lubricate as necessary.

7. Ensure that the aerial is free in the fairlead and examine the fairlead for cleanliness and cracks.
8. Examine the motor generator mounting for security.
9. Examine the cable connections to the motor generator for cleanliness and security.
10. Conduct a ground test of the wireless equipment.
11. See that all wireless spares are serviceable and properly stowed.
12. Test the tapping keys for correct functioning.
13. Test the signalling lamp for serviceability.

Fuselage

1. Examine the fixed aerial attachment and lead in for security.
2. See that the aerial strain and lead in insulators are clean, secure and not damaged.

General

1. Test the navigation, identification and lighting circuits for continuity by operating the switches and push buttons.
2. Make the necessary entries on the inspection form.

Inspection Every 10 hours

Cockpit and Cabin

1. Check the level and specific gravity of the electrolyte in the accumulators. Clean off any moisture and grease the terminals as necessary.
2. Inspect the accumulator stowage and adjacent aeroplane structure for corrosion.
3. Run out the aerial to its full length and inspect it for kinking, fraying and excessive stretch.
4. Test the wireless earthing system for continuity.
5. Test the insulation between the aerial and earth.

Inspection Every 20 hours

Cockpit and Cabin

1. Check the operation of the landing lamp controls and ensure that full and free movement of the lamp is obtainable.
2. See that the filaments of the landing lamp are in sound condition.

General

1. Inspect the fuze boxes for cleanliness and security. See that the fuzes and spares are serviceable and of the correct value.
2. See that all connections to the switches, plugs and sockets, and fuze boxes are secure.
3. Examine all switches, plugs and sockets for cleanliness and security.

Inspection Every 40 hours

Power Plant

1. Clean the engine-driven generator commutator and inspect the brushes for freedom of movement.

Cockpit and Cabin

1. Clean the motor generator commutator and inspect the brushes for freedom of movement.
2. Check the accuracy of the ammeter and voltmeter readings.
3. Inspect the accumulator cut-out for cleanliness and correct operation.

General

1. Inspect all lamp bulbs for signs of discoloration.
2. See that all lamp glasses are clean and secure.

Inspection Every 120 hours

Power Plant

1. Inspect the engine-driven generator bearings for play and the commutator for scoring.
2. Inspect the engine-driven generator brushes for wear and the springs for correct tension.

Cockpit and Cabin

1. Inspect the motor generator bearings for play and the commutator for scoring.
2. Inspect the motor generator brushes for wear and the springs for correct tension.

Main Planes

1. Examine the fuel tank potentiometer of the fuel gauge for defects and check the functioning.

General

1. Inspect for security all bonding and screening throughout the aeroplane and test with lamp or buzzer.
2. Test all electric cables by megger for effective insulation.

RECORDS OF INSPECTIONS

In the specimen schedule at the end of the between flight inspections, a note has been made to the effect that " the details of this inspection need not be recorded." The operations covered by between flight inspections, except possibly the replenishment of fuel, oil and coolant systems, are not of sufficient importance to warrant the keeping of records. The periodical inspections, however, are more important, and it is essential to keep a record showing when and by whom these were done. Each aeroplane has its own log book, which forms a complete history sheet of all work done on the aeroplane. A general entry regarding inspection work could, of course, be made in the log book, but if the systematic inspection system advocated is used, it is more suitable to keep a separate record of inspections on which a certain amount of detail can be placed.

AEROPLANE INSPECTION FORM

Aeroplane type and number	
Aero-engine type and number	
,, ,, ,, ,,	
,, ,, ,, ,,	
,, ,, ,, ,,	

Engine Changes.	
No. from.	No. to.

....Unit ....

Period of..........................commencing...................

.... Serial No......... No. of Sheets...........

Engineers

Fitter ....

Rigger..

Wireless Mechanic.....................................

Instrument Maker ....

DAILY INSPECTION CERTIFICATE.

Certified that I have made the daily inspection in accordance with the Inspection Schedule.

Date.	Airframe. Hrs. Flown.	Engine. Hrs. Run.	Engine. Hrs. Run.	Engine. Hrs. Run.	Engine. Hrs. Run.	Daily Inspection—Engineers.					Fuel.	Oil.	Coolant.	Engineer responsible.
						Fitter.	Fitter.	Rigger.	Wireless.	Instruments.				

PERIODICAL INSPECTION CERTIFICATE

Certified that I have made the periodical inspection in accordance with the Inspection Schedule.

Periodical Inspection.	Date.		Initials.	Check Inspection.			Periodical Inspection.	Date.		Initials.	Check Inspection.			Periodical Inspection.	Date.		Initials.	Check Inspection.		
	Com.	Fin.		Assembly Groups.	Initials.	Rank.		Com.	Fin.		Assembly Groups.	Initials.	Rank.		Com.	Fin.		Assembly Groups.	Initials.	Rank.
RIGGER.							FITTER.							FITTER.						
INSTRUMENT MAKER.							WIRELESS MECHANIC.													

The record form should be as simple as possible. It should link up with the whole maintenance procedure and should form a history sheet of inspectional work from which the responsibility of the inspectional staff for any particular operation can be determined. It should be complementary to the log book, but need not necessarily be in such a permanent form. It is quite feasible, for example, to maintain a monthly record sheet, provided that each form shows clearly the continuation from the previous form, and certain general extracts are made to the permanent record, *i.e.*, the log book. Inspections can be recorded by individual operations, by groups, or as complete daily, 10, 20, 40 or 120 hour inspections under trade headings. Specimen inspection forms are given on pages 94 and 95, where the daily and periodical inspections are shown separately. The forms are self-explanatory with the possible exception of the reference to assembly groups under each periodical inspection. It is usual to employ a code to denote the inspectional group for recording purposes, *i.e.*, TU for tail unit, MP for main planes, PP for power plant, etc., and, dependent upon the detail which is required, it is possible to allot numbers to the operations in each group.

Defects and Modifications

If during a periodical inspection a defect is discovered on one aeroplane it may be necessary pending detailed investigation to call for special inspection of all aeroplanes for similar defects and possibly for repetition at certain intervals. Detailed investigation of the defect may not result in a decision to modify the defective part ; it may suffice to include the special inspection as a permanent operation. If, however, the part is modified, the special inspection will become unnecessary and should always be cancelled formally. Where the system is in force at several aerodromes under the same control, any additional inspection found necessary as a result of a defect must be notified to each inspectional staff for inclusion in their schedules, together with any subsequent deletion or amendment.

Special Inspections

Special inspections following abnormal stresses during aerobatics or landing should be made at the discretion of the local staff and framed to meet the particular circumstances of the incident.

Conclusion

The system advocated is intended for guidance in framing a system of aeroplane inspection and maintenance which will ensure maximum serviceability with minimum interference to flying.

We are indebted to the Air Ministry and to Messrs. A. V. Roe Ltd. for permission to reproduce the photographs above illustrating the inspection of an " Avro " " Anson " aeroplane.

THE "GIPSY MOTH"

(TYPE D.H. 60 G & M)

WITH NOTES ON THE D.H. 60, 60 X, 60 T, MOTH MAJOR AND MOTH SEAPLANE

By A. J. Brant
Service Manager, de Havilland Aircraft Co. Ltd.

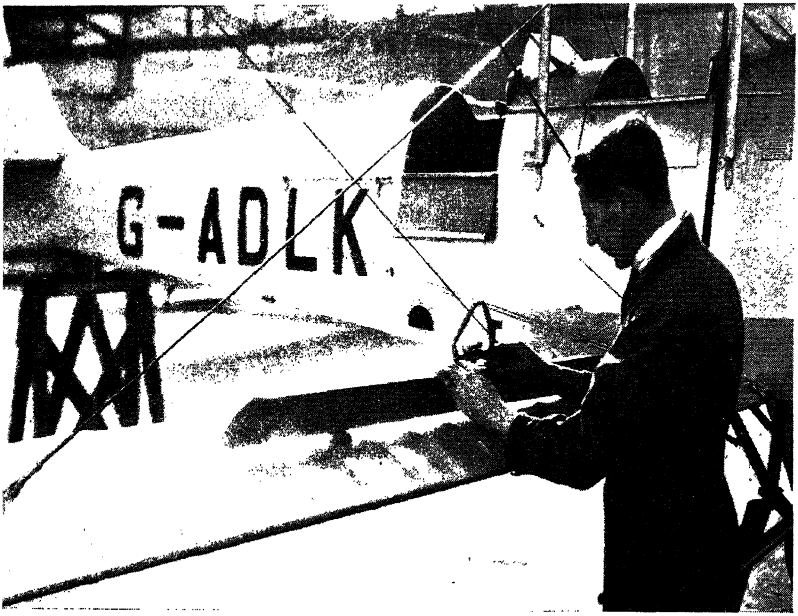


Fig. 1.—Rigging operations (1).

Checking dihedral with straight-edge and protractor. This is a stage in the truing-up operations (see also Figs. 11 and 12).

We feel we can hardly do better than take the "Moth" for the first contribution to this series as being the example of a light aeroplane, particularly as many hundreds of these aeroplanes have been manufactured, the greater proportion of which are operating and will continue to operate for many years to come.

Type D.H. 60

In 1925, Capt. Geoffrey de Havilland foresaw the need for, and the possibilities of, a really practical two-seater light aeroplane, and the

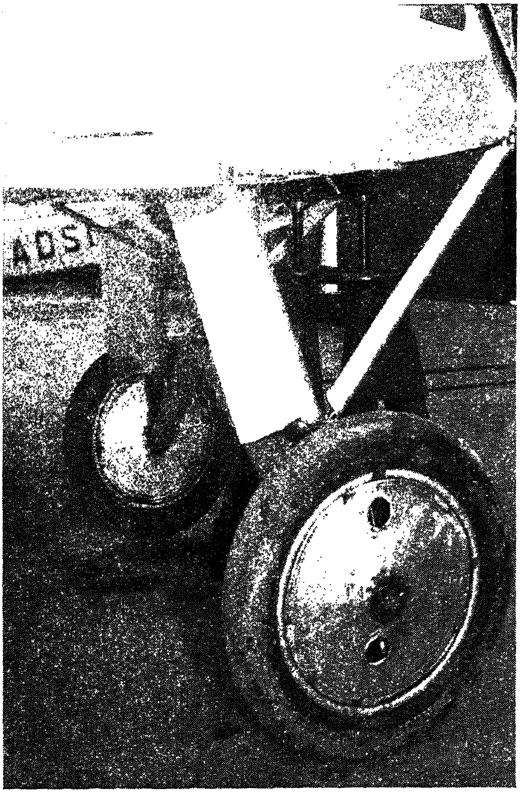


Fig. 2.—RIGGING OPERATIONS (2).
Showing trestle under front fuselage.

type D.H. 60 came into being. The power unit was the 65 h.p. Mark I. Cirrus engine developed for this aeroplane by Major Frank B. Halford in collaboration with Capt. de Havilland.

Approximately sixty of these aeroplanes were built and principally went to equip the clubs of the Light Aeroplane Movement, then being started, with official encouragement.

From that time the "Moth" has developed, by the foresight of the designer and constructor, side by side with engine development to widen the range of its usefulness. The second series of "Moths" to follow the original D.H. 60's are officially known as the D.H. 60 X, but before passing to a brief description of this type we might add, that a number of D.H. 60's were also fitted with 80 h.p. Mark II. Cirrus engines, and several of these were later converted to 90 h.p. Mark III. Cirrus engines by the engine manufacturers for demonstration and sporting events.

Type D.H. 60 X

The 60 X was the logical development of the original 60, but only a comparatively few parts are interchangeable. The general fuselage construction is similar, but not identical as it is constructed to accommodate the engine lower in the frame for the purpose of a better cowling line and shape. The undercarriage, although still of the straight axle type, is given a wider track; the centre section, fuel tank and main wing structure, although similar in arrangement are actually all different in detail. These changes were all necessary to incorporate the experience

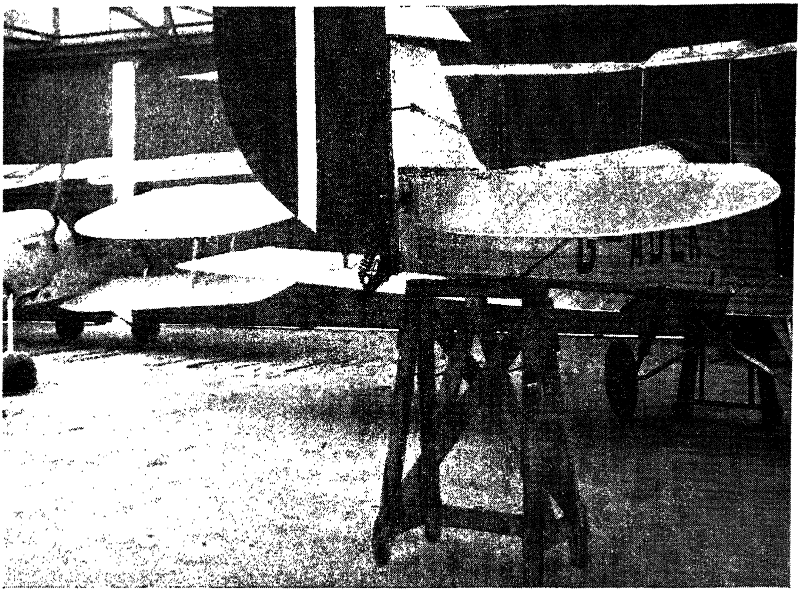


Fig. 3.—RIGGING OPERATIONS (3).
Showing trestle under rear of fuselage.

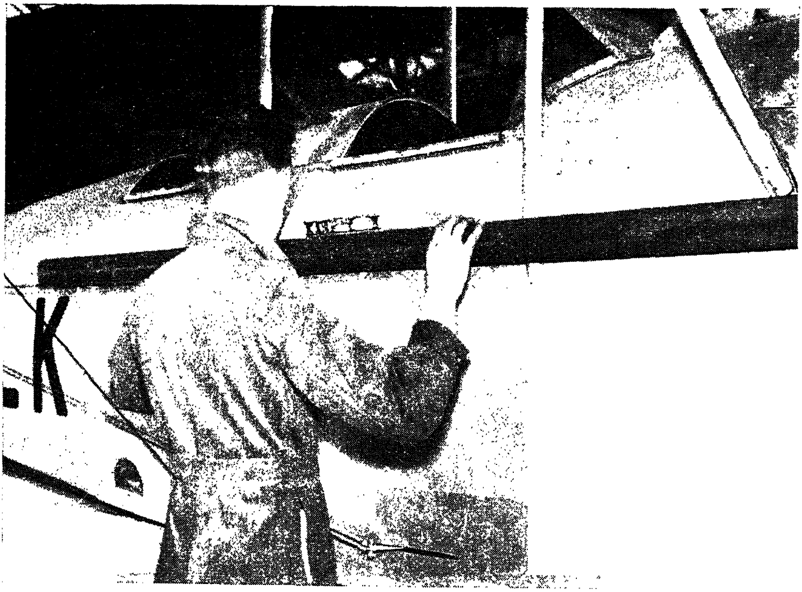


Fig. 4.—RIGGING OPERATIONS (4).
Levelling metal fuselage with straight-edge on datum pegs.

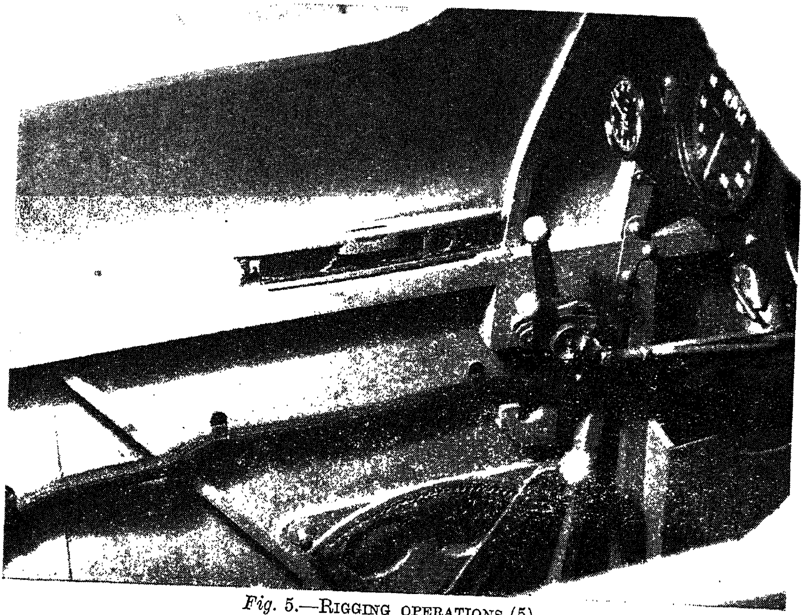


Fig. 5.—RIGGING OPERATIONS (5).
Levelling on longeron in pilot's cockpit (60 X and G).

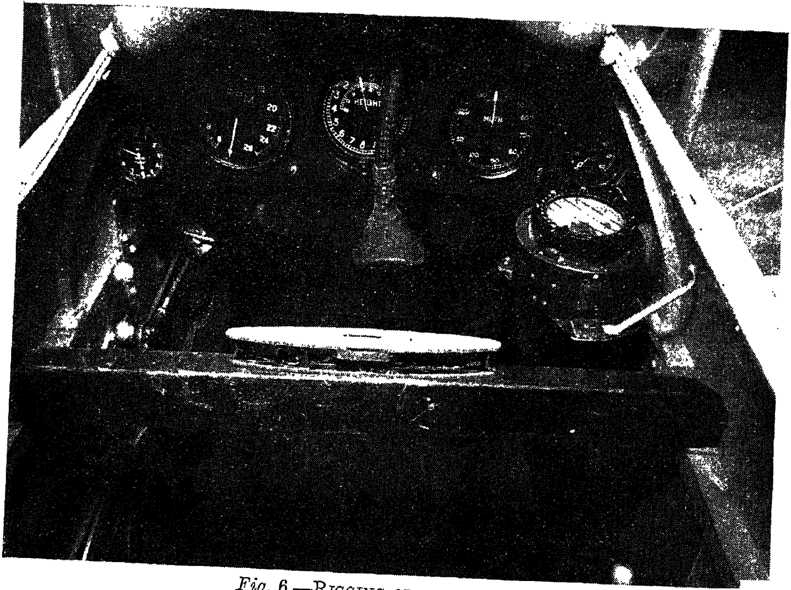


Fig. 6.—RIGGING OPERATIONS (6).
Showing short straight-edge across longerons in cockpit.

gained with the original aeroplanes and to obtain the improved, general all-round, performance desired. The 60 X fuselage, tail unit and wing structure arrangement has not been altered on the latter 60 G types and a great number of the 60 G parts and components are suitable for the 60 X, but the 60 X components are not necessarily suitable for the 60 G, as, although they are the same from the interchangeability point of view, the 60 G components are all different drawing numbers owing to a redesigning for strengthening of the detail parts to obtain a higher maximum permissible all-up weight on the Certificate of Airworthiness. As previously mentioned the standard 60 X undercarriage is of the straight axle type, but a number of these aeroplanes have had the 60 G split-axle type fitted.

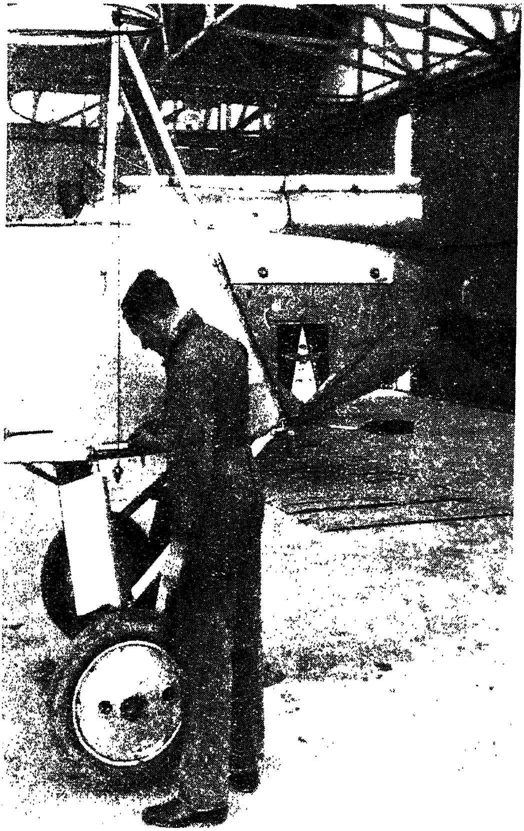


Fig. 7.—RIGGING OPERATIONS (7).
Measuring stagger by means of plumb bobs.

Type D.H. 60 G

The type D.H. 60 G is the most famous of the "Moth" series and is generally known as the "Gipsy Moth" and coincides with the advent of the 100 h.p. Gipsy I. engine and produced in great quantities. In addition to the wing structure the fuselage is of wooden construction. The Gipsy II. 120 h.p. engine was also fitted to this aeroplane when required.

Type D.H. 60 M

The type D.H. 60 M "Moth" is different only from the 60 G in as much as it has a fuselage of metal construction and is commonly referred to as the "Gipsy Metal Moth."

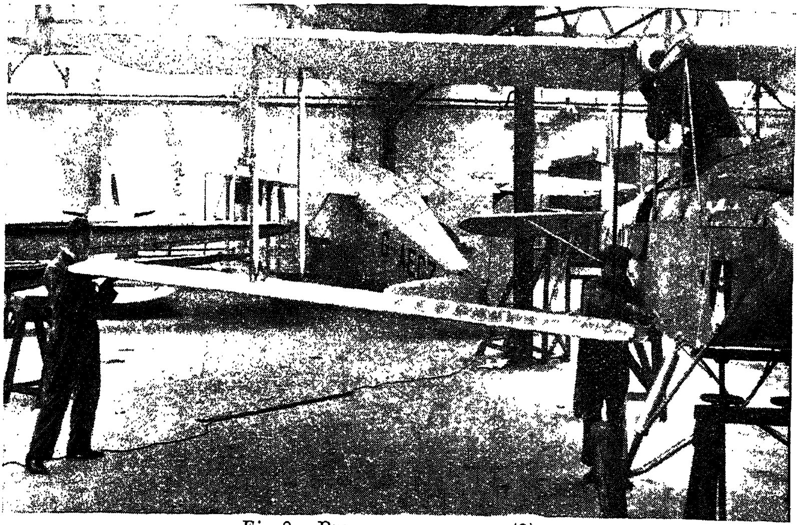


Fig. 8.—RIGGING OPERATIONS (8).

Fitting main planes—one rigger is lifting the wing tip, another is lifting at the root-end rib with wings about half back, and the third man is putting in the top rear hinge bolt.

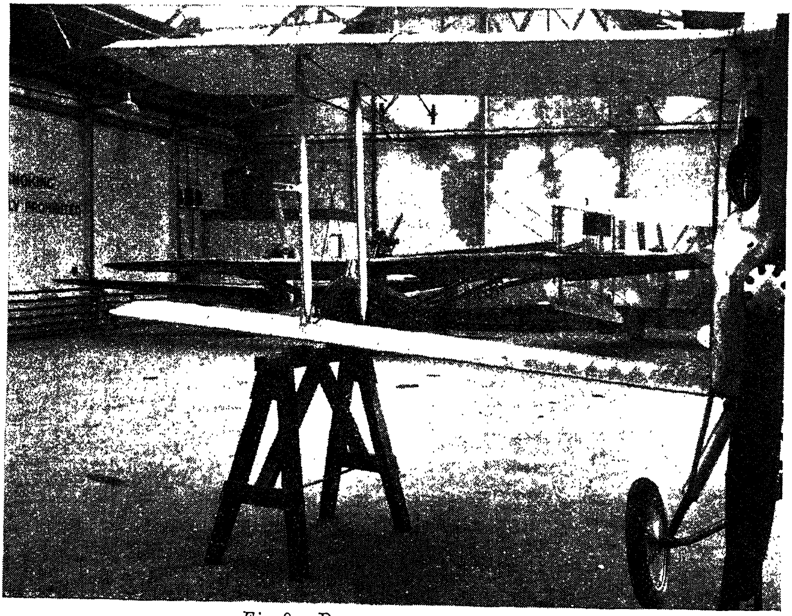


Fig. 9.—RIGGING OPERATIONS (9).

Balancing the airframe with one set of wings on, by means of a light trestle under the outer strut.

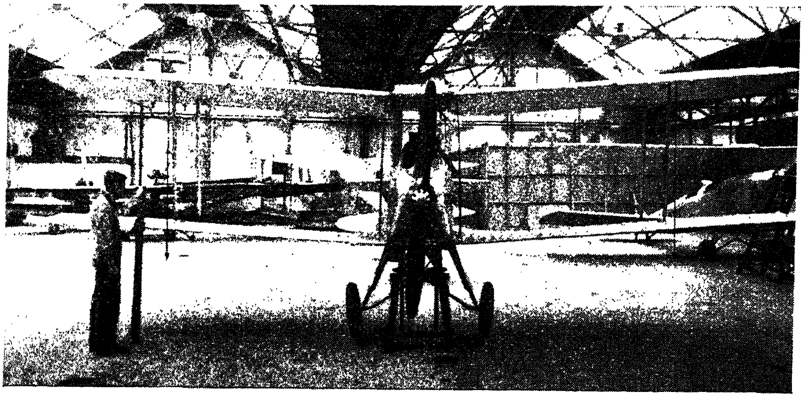


Fig. 10.—Rigging operations (10).

Front view of aeroplane with plumb bobs at outer struts and ready for truing up by means of straight-edge and protractor (see also Fig. 1).

N.B. These two types, G and M, being the most common, will be used as the example for the main instructional portion of this article.

Type D.H. 60 T

The D.H. type 60 T is known as the "Moth Trainer." One production batch only of this type of aeroplane was manufactured for the operation

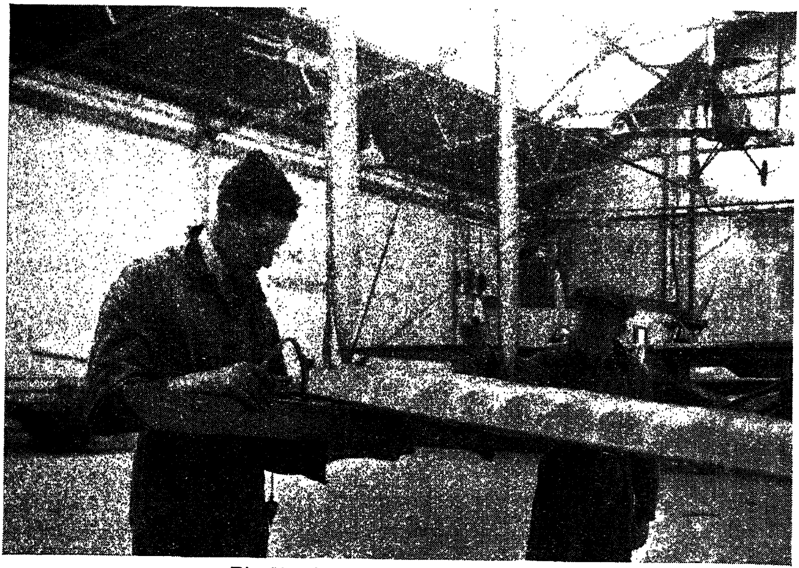


Fig. 11.—Rigging operations (11).

outer strut with
ling wire.

of a flying school on the Continent. The type actually is of very little interest to the student or ground engineer, but there is always a possibility of having to deal with the type and the few notes to be given will not be amiss. The 60 T has a fuselage of metal construction similar to the 60 M with various modifications to facilitate the exit from the cockpits of the pilot and pupil with parachutes. The long exhaust take-away pipe was eliminated by the fitment of a special manifold with an outlet from the front end. This enabled large exit doors to be fitted from the front cockpit. The following are the other essential differences.

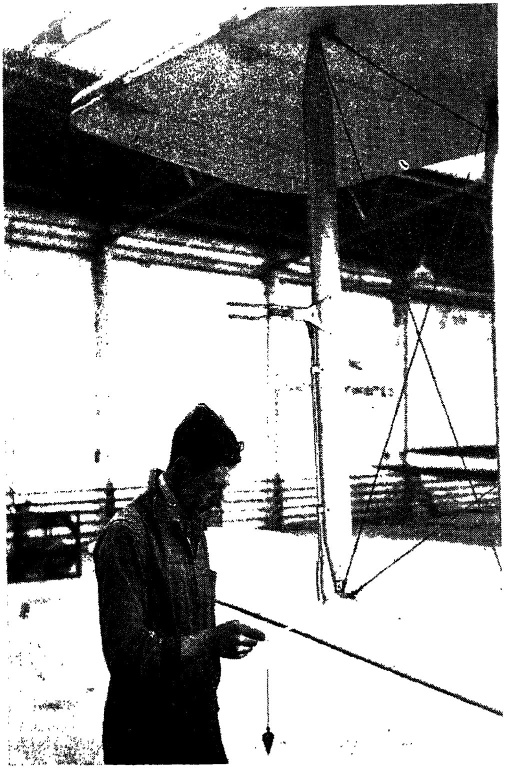


Fig. 12.—Rigging operations (12).
Measuring stagger at outer strut with a plumb bob.

(1) On the rigging drawing the lift wires of the main plane are :—

Front $\frac{11}{32}$ in. instead of $\frac{5}{16}$ in.
Rear $\frac{9}{32}$ in. instead of $\frac{1}{4}$ in.

The rear lift wire instead of being attached to the rear spar joint at the fuselage is now attached to the front spar joint.

(2) The differential aileron control is to be set at an angle of 44 degrees.

(3) The angle of incidence of the tail plane is to be 45 minutes positive to the top fuselage longeron.

(4) The 120 h.p. D.H. Gipsy II. aero engine is fitted as standard in the "Moth Trainer."

"Moth" Major

A small amount of redesigning work has been carried out on the 60 G "Moth" to make it suitable for the Gipsy Major inverted engine. The fuselage is of wooden construction aft of the fireproof bulkhead; the engine bay structure being metal—of steel tube ; a steerable tail skid

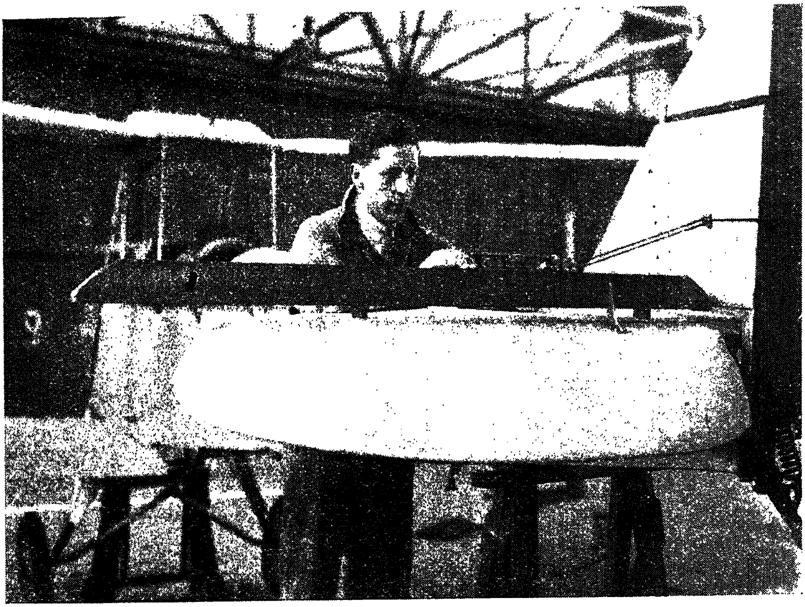


Fig. 13.—RIGGING OPERATIONS (13).
Checking rear spar on tail plane for level.

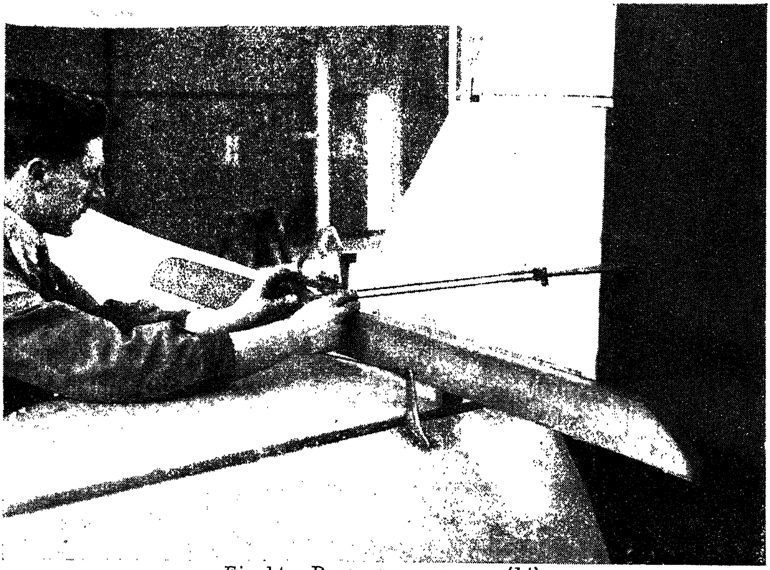


Fig. 14.—RIGGING OPERATIONS (14).
Checking incidence of tail plane.

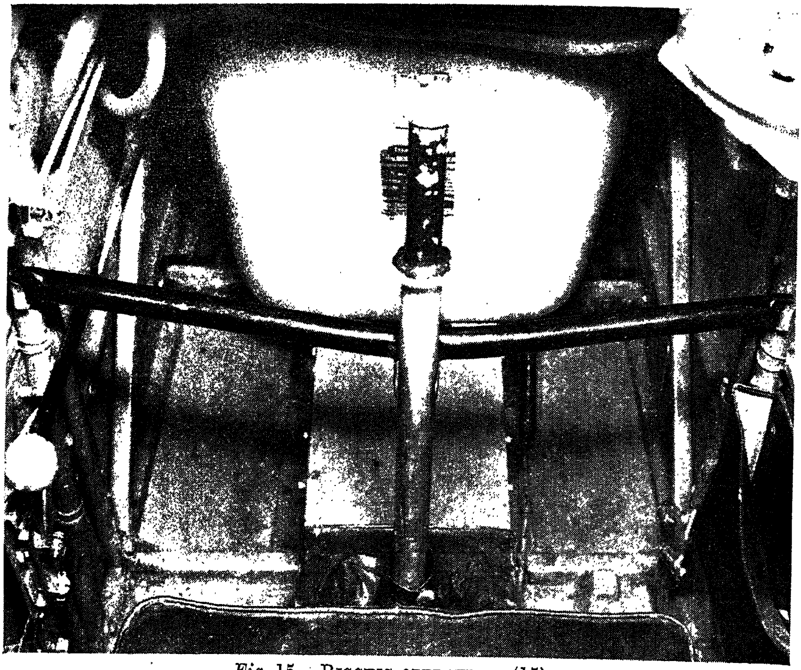


Fig. 15.—RIGGING OPERATIONS (15).
The cockpit, showing control stick jig in position.

is incorporated and the root end wing attachment joints are redesigned in connection with a high permissible all-up weight. The general construction, rigging and maintenance, closely follows that of the 60 G and the information given later will be of general guidance in connection with this type.

"Moth" Seaplane

The types 60 X, G, and M, have also been produced as seaplanes and information on these is included later.

CONSTRUCTION

The Main Planes

The main planes are a single bay biplane structure. Each plane consists of two I-section spruce spars with leading and trailing edges and ribs of wooden lattice structure; the wing tip bends are of light alloy tubing; the internal drag struts are of steel tube, the lugs for the swage rod and high tensile steel wire bracing being integral with the tube, completing a structure which is not affected by any slight shrinkage which might take place in the wooden spars. The main drag bracings are dupli-

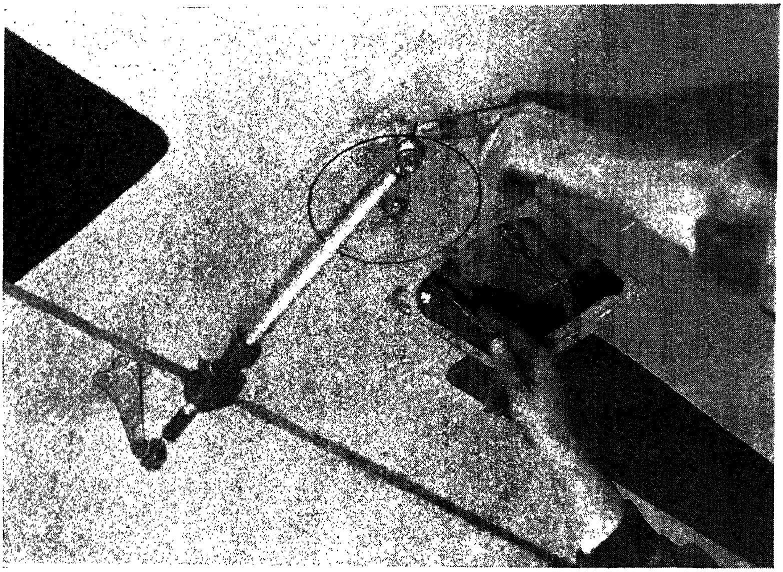


Fig. 16.—Rigging operations (16).

A view underneath the plane showing sprocket, differential and connecting rod, and showing adjustment of turnbuckles. The finger of the left hand is pointing at the mark for angle on plane.

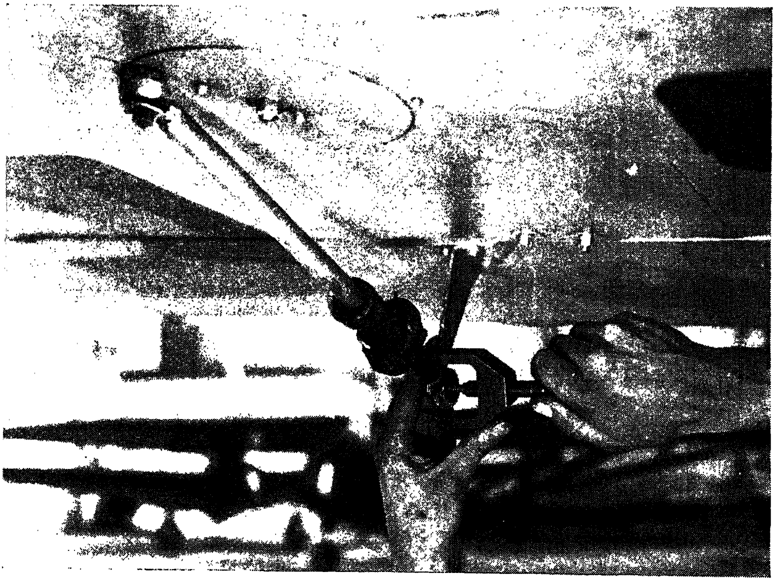


Fig. 17.—Rigging operations (17).

Extracting ball race from connecting rod arm.

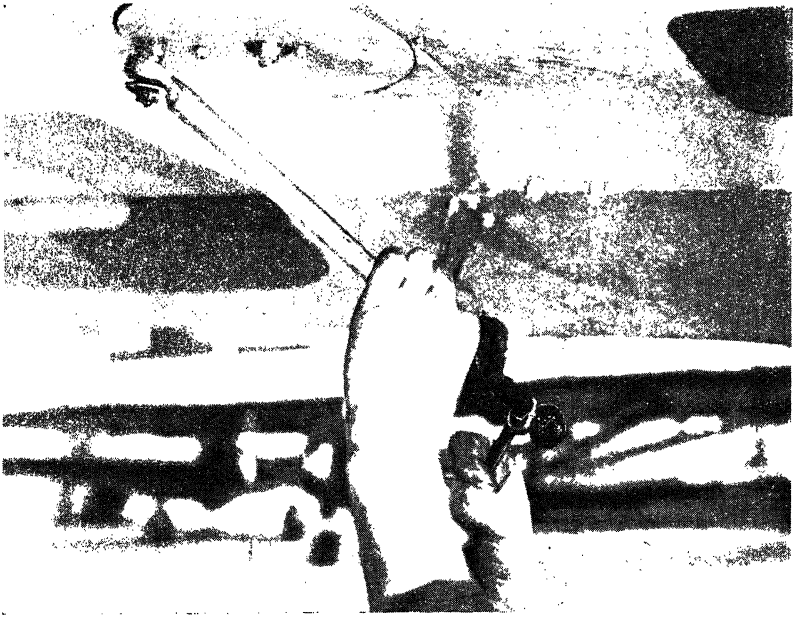


Fig. 18.—RIGGING OPERATIONS (18).

Adjusting length of connecting rod for aileron droop with a spanner.

cated; the centre section struts are of oval section steel tubing; the interplane struts are of spruce with steel end sockets.

Fuselage

The 60 G fuselage is of wooden construction, spruce longerons and struts being built in a jig with three ply stressed covering. The main structure is jointed with fishplates at a point immediately behind the pilot's cockpit.

The 60 M fuselage is steel tube construction. In addition to the above, however, there are the lower main cross-members terminating with attachment fittings for root ends, for the lower main planes, which are specially constructed parts. A small quantity of $\frac{1}{4}$ in. diameter by 22 gauge steel tubing is also used as stays for the rear fuselage fairing formers. Tubular construction has welded joints strengthened by stiffening plates of mild steel.

Front Fuselage (Cockpit Section)

The front fuselage, the sides of which are parallel in plain view, is constructed of two flat sides, the junction joints of the structure and diagonal members to the longerons being welded in a jig. All joints are reinforced with side plates welded on. All holes in these side units

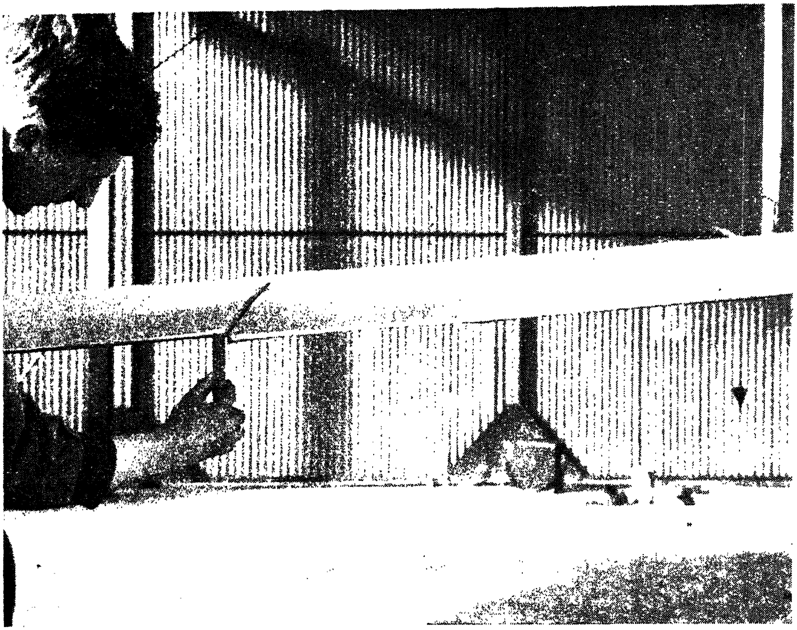


Fig. 19.—Rigging operations (19).
Measuring ¼ in. droop on aileron.

are also jig drilled, and the side forms a replaceable unit should the need arise. The side units are assembled with no welding by the bolted cross-members, which complete the front fuselage framework.

Engine Bay Structure

The engine bay structure consists of two side frames, each constructed of three square tubes in triangular form, welded flat in a jig at the joints. The joints are reinforced with side plates welded on. The side units are assembled to the front fuselage section by bolted fishplates, and being jig made and drilled, form replaceable units. A stay tube from the right-hand rear engine foot to the bottom left-hand joint of the fuselage braces the structure against side loads.

Rear Fuselage (from rear of Pilot's Seat to Stern Post)

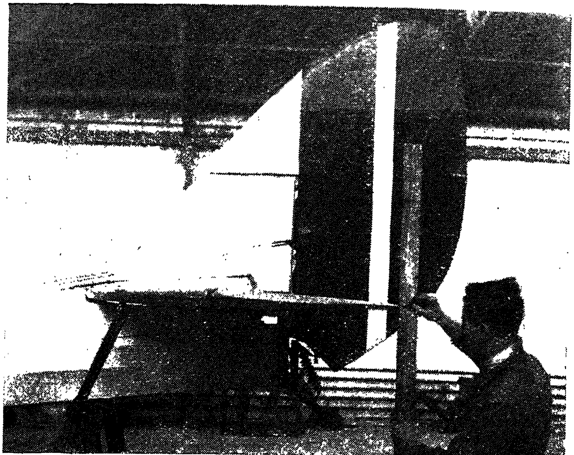
This section, together with the front fuselage and engine bay described, completes the fuselage framework.

The rear fuselage is a completely rigid welded-up unit, jig built, and is a replaceable unit. The four longerons are of square tube and struts, diagonals and cross-members of round tubing. All joints are reinforced by side plates welded on.

It will be appreciated from the foregoing description that in the

Fig. 20 (*right*).—RIGGING OPERATIONS (20).

Measuring elevator movement. Showing vertical straight-edge held against trailing edge. The elevator is here seen in the neutral position.



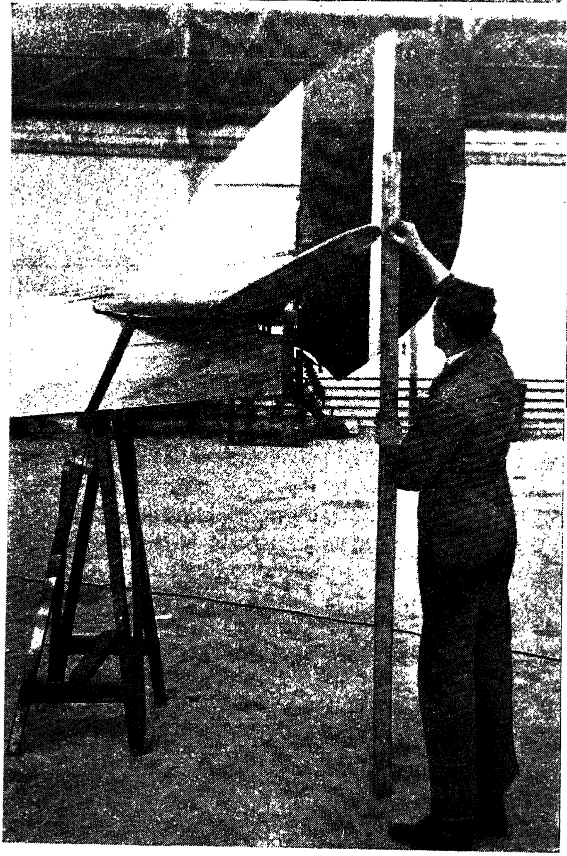


Fig. 21 (*left*).—RIGGING OPERATIONS (21).

Measuring elevator movement. The elevator is here seen right up.

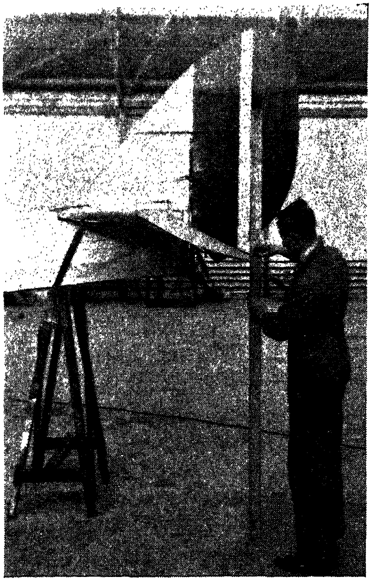


Fig. 22.—Rigging operations (22).

Measuring elevator movement. The elevator is here seen right down.

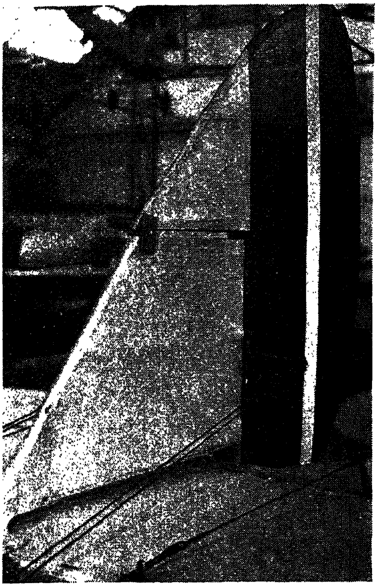


Fig. 23.—Rigging operations (23).

Showing fin and rudder with rigger putting clamp blocks to centralise rudder.

event of major damage the replaceable section can be obtained and fitted with little or no constructional experience.

It more often happens, however, that minor and localised damage occurs involving a section of longeron, and perhaps a joint or strut.

In certain cases these rectifications can be dealt with by fishplates and bolting and, although not generally favoured, repairs have been successfully carried out when welding equipment has not been available. A scheme for typical repairs on this system has been approved for civil aeroplanes.

It is felt, however, that welded repairs are more satisfactory and a scheme for typical repairs has been approved. Generally speaking, it provided that any section of longeron or joint can be cut out and replaced provided the approved fishplates and joints are made in an approved position. This is, of course, to prevent joints being made towards the centre of a bay or strut where the maximum stress occurs.

Tail Unit

The tail unit is of wooden construction and fabric-covered. Rudders and elevators have trailing edge bends of light alloy tubing. The tail plane is not adjustable in flight, all " trimming " being done by spring tension on the elevators, adjustable by a quadrant in the pilot's cockpit.

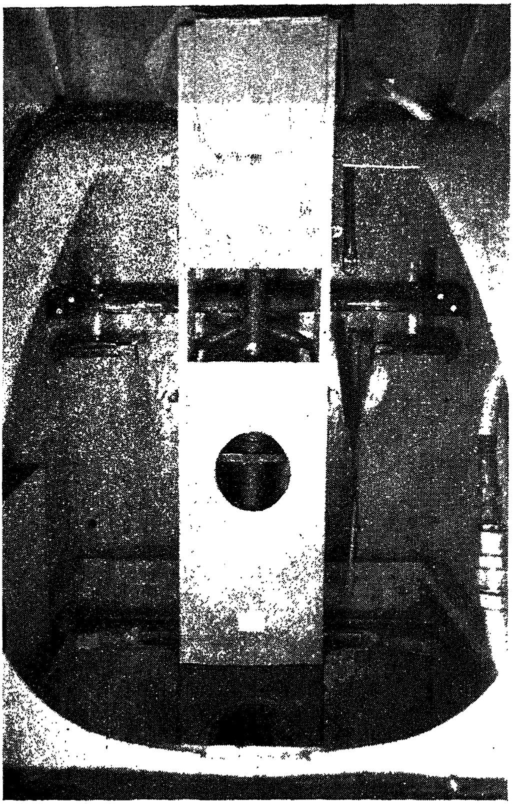


Fig. 24.—RIGGING OPERATIONS (24).

This picture was taken looking straight down in the cockpit to show rudder bar square.

The load on these springs is always light. A spring is fitted to the starboard side of the rudder bar in order to counterbalance the load upon it caused by the airscrew slipstream.

Undercarriage

The undercarriage is of the divided or split axle type. Spring legs on the earlier aeroplanes embodying rubber-in-compression springing were used. On later aeroplanes a steel spring leg was introduced, further details of which are given later. The top end is attached to the fuselage lower longeron and the other end to the wheel end of the cranked half axle which terminates at a tripod fitting under the fuselage. The structure is completed by a forwardly inclined stay tube from the lower end of the leg casing to the fuselage. 15 in. diameter Dunlop wheels which carry a tyre of 4 in. section are fitted on the early aeroplanes and the Dunlop low pressure 19 in. by 7 in. tyres and wheels on later types.

Tail Skid

Type G (*wooden fuselaged model*).—The tail skid is sprung with a steel tension spring.

Type M (*metal fuselaged model*).—The tail skid is sprung with a steel compression spring.

The tail shoe is easily detachable for renewal when worn.

A hook fitting is provided on the tail skid for the lifting handle, which is used when the aeroplane has to be moved with the wings folded.

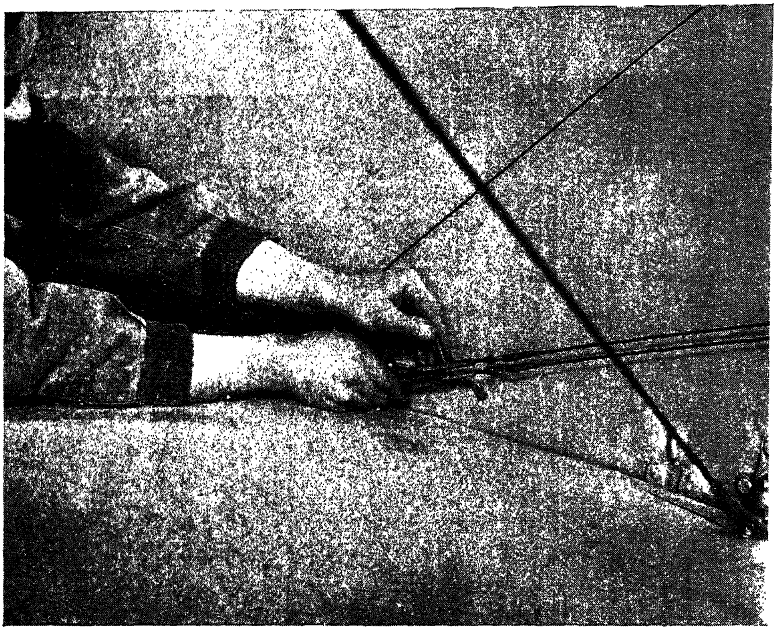


Fig. 25.—RIGGING OPERATIONS (25).
Adjusting the rudder cables.

Controls

All control-operating gear is housed in a control-box running centrally along the cockpit floor, forming a unit which can be easily removed for periodical inspection. The controls in the front cockpit are quickly detachable—the control-columns by withdrawing a safety locking pin, and the rudder by removing the connecting rod.

The two control-columns connect with a shaft carrying a lever which transmits side movement to the ailerons by cables, and fore and aft movement by link tubes to a cross-shaft behind pilot's seat, from which cables run direct to the elevator levers. Rudder cables run direct from attachment on outer end of rear rudder bar to the levers on the rudder.

Petrol System

The normal petrol supply is 19 gallons, carried in a tank in the top centre section. The supply from the filter to the carburetter is by petroflex tubing. A filter is bolted to the fireproof bulkhead behind the engine. The petrol cock is within easy reach of the pilot's hand.

RIGGING INSTRUCTION

Main Planes

To re-ri dismantling, the following procedure
should be

Fig. 26 (*left*).—FOLDING OF WINGS (1).

The man is standing on the wheel and has his hand on the jury strut.

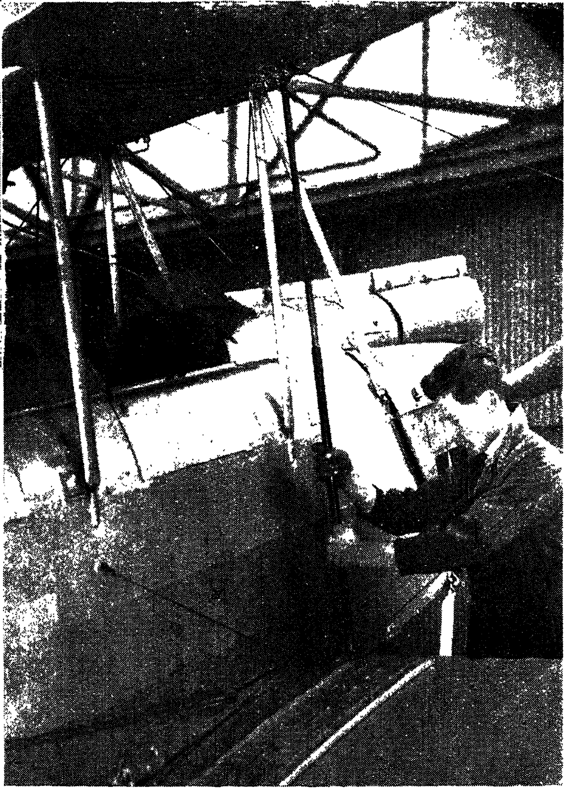


Fig. 27 (*right*).—FOLDING OF WINGS (2).

Putting the jury strut in position.

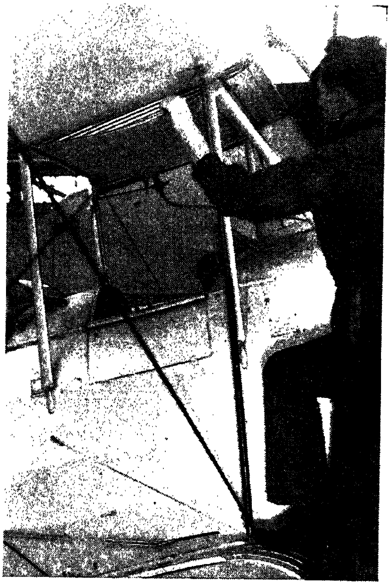


Fig. 28.—FOLDING OF WINGS (3).

The top locking bolt has just been pulled out.

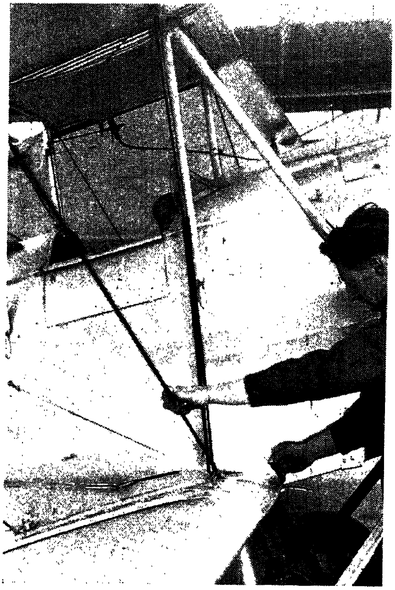


Fig. 29.—FOLDING OF WINGS (4).

Pulling out bottom locking bolt while holding flying wire.

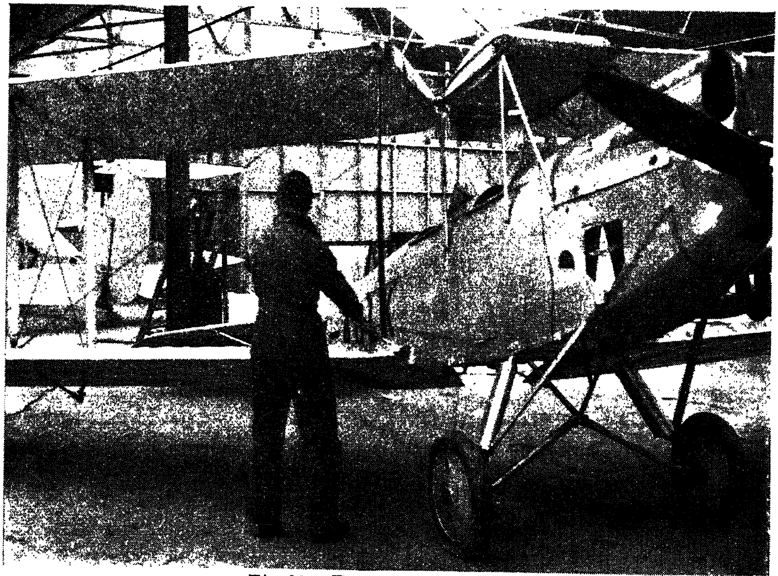


Fig. 30.—FOLDING OF WINGS (5).

The wings are here shown half back.

Fig. 31.—FOLDING OF WINGS (6).

The wings are now right back and are being fixed to the bolt on the fuselage.

The fuselage should first be levelled up on trestles with the undercarriage clear of the ground.

The top longeron should be horizontal and the fuselage level laterally. This may be checked by means of a straight-edge and spirit-level placed on the ash blocks screwed to the top longerons in the rear cockpit.

Centre Section, complete with tank, should now be placed on trestles, and the centre section struts and wires, complete with fork-ends, attached. The fork-ends should be screwed the same number of turns on each end of the wire. The centre section should now be erected on the fuselage and plumb bobs dropped from the centre section spar eyebolts. The stagger and lateral level of the centre section should then be checked. The stagger is 3½ in., and can be measured against the centre line of bottom front spar fitting on fuselage, and can be adjusted by means of the front section centre struts. The lateral level of the centre section can be checked by measuring from plumb bobs to side of fuselage, and adjustment is made by the bracing wires.

The Main Planes should now be boxed up. The top and bottom planes of one side are stood up on their leading edges, and the interplane struts, jury struts and bracing wires inserted. The stagger may be very roughly set by screwing the incidence wires in their fork-ends with an equal number of turns at each end. Care should be taken that the struts are replaced correctly in their front and rear positions.

Fig. 32.—REMOVING AND INSPECTING CONTROL UNIT FOR ANNUAL OVERHAUL (1).
The control unit drawn half-way out of the cockpit.

The planes are now ready for attachment to the fuselage. Three men are required to do this: one should lift the wing tip, one the root end, and the third put in the hinge bolts.

The rear top hinge bolt should be removed, the planes lifted and brought up to the fuselage, and a $\frac{5}{16}$ in. diameter bolt temporarily inserted in the top rear hinge.

The rear flying wire should now be loosened until the rear root end of the bottom plane drops sufficiently to engage the bottom hinge pin on the fuselage. Tighten rear flying wires and engage front draw pins. At this stage a trestle should be placed under the interplane struts to prevent the weight of the wings on one side tipping the airframe over.

The rear landing wires should now be loosened and the $\frac{5}{16}$ in. bolt temporarily inserted should be taken out and the proper hinge bolt fitted.

It is as well to line up the hinge fitting on the centre section and rear span by means of a $\frac{7}{16}$ in. tapered pin before inserting the hinge pin—this prevents damage to the fork fitting on the centre section, which might result if the holes were not in alignment.

The planes on the other side can now be rigged in a similar manner.

The Rigging Angles should be checked as indicated on the rigging drawing.

Fig. 33.—REMOVING AND INSPECTING CONTROL UNIT FOR ANNUAL OVERHAUL (2).

The control unit on its side on two trestles is being closely examined with the aid of an electric torch.

Fig. 34.—REMOVING AND INSPECTING CONTROL UNIT FOR ANNUAL OVERHAUL (3).

The unit is here shown the right way up with control slides in and the controls being worked for final inspection.

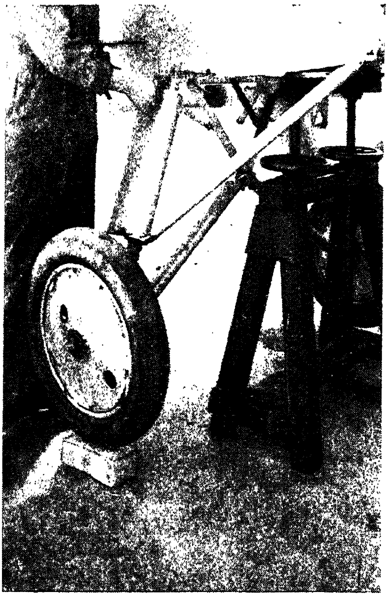


Fig. 35.—REMOVING UNDERCARRIAGE LEG FROM AIRFRAME (1).

The undercarriage with wheels clear of the ground and wood blocks under the tyre. The adjustment bolts are being undone.

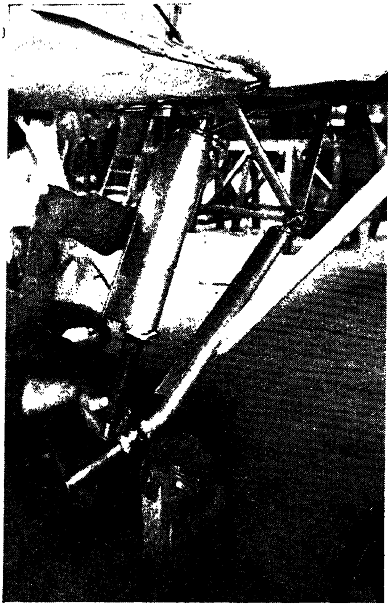


Fig. 36.—REMOVING UNDERCARRIAGE LEG FROM AIRFRAME (2).

The leg is now disconnected and is being held clear of the axle and airframe.

The support wire should now be fitted. If, after folding the planes, the front top locking bolts do not go in easily, the front landing wire should be slackened a little and the front flying wire tightened up until the centre section and wing root fittings are in alignment and the locking bolts easily inserted.

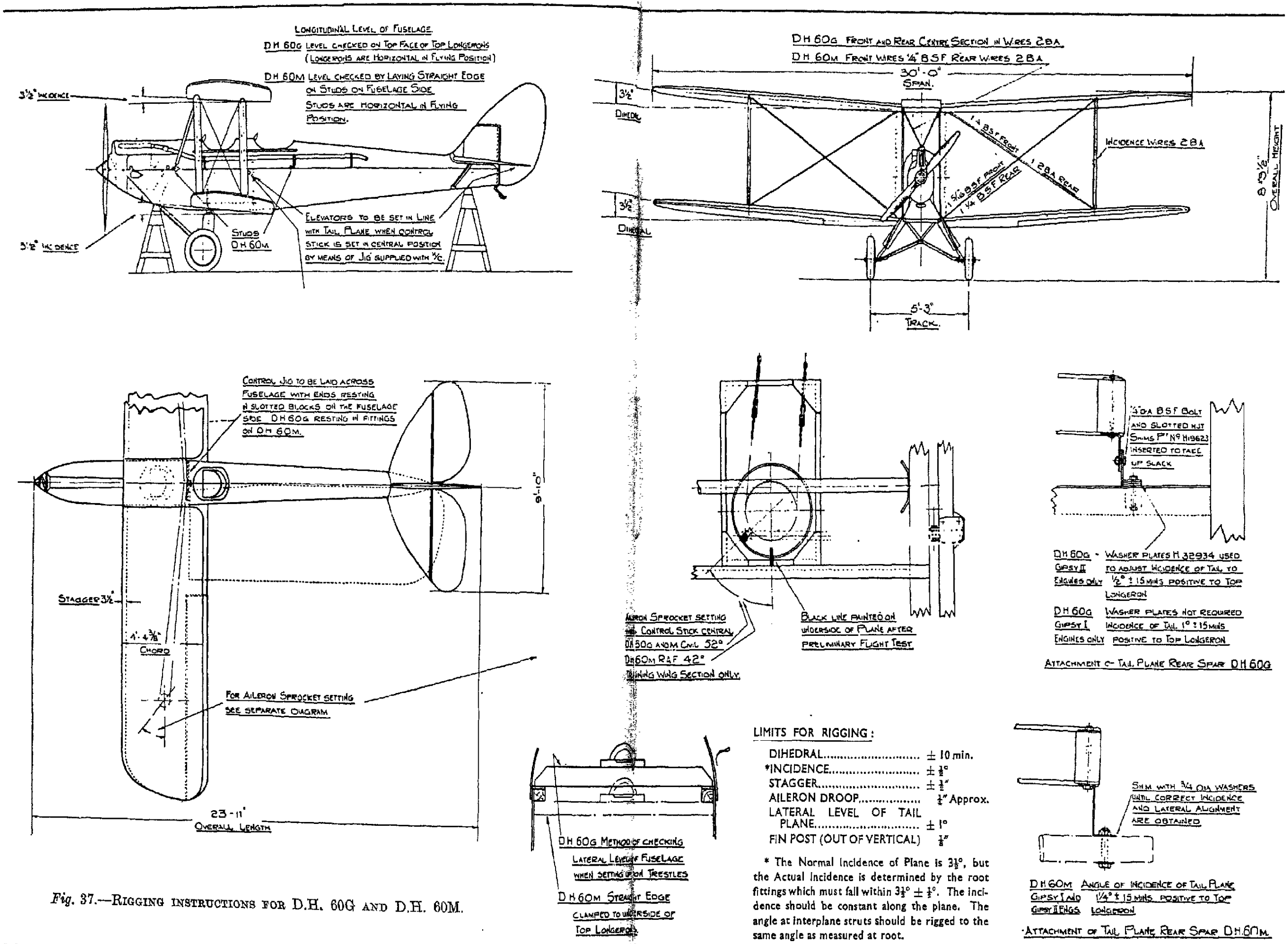
Undercarriage

The undercarriage should be rigged square on the fuselage, plumb bobs may be dropped from each side of the fuselage and a measurement taken from the plumb bob to the wheel hub. These measurements should be the same on both sides.

Tail Plane

Any play in the eyebolts attaching the front spar to the fuselage should be taken up by the shims and also by shims at the rear spar attachment.

SPECIAL NOTE. The rigging diagrams provided should be used for general guidance and information only, and the aeroplane Log Book must be referred to for the actual rigging figures for the individual aero-


Longitudinal Level of Fuselage.
DH 60G Level checked on Top Face of Top Longerons (Longerons are Horizontal in Flying Position)
DH 60M Level checked by laying Straight Edge on Studs on Fuselage Side
Studs are horizontal in Flying Position.
3½° incidence
3½° incidence
Studs DH 60M
Elevators to be set in line with Tail Plane when control stick is set in central position by means of Jig supplied with A/C.
DH 60G Front and Rear Centre Section in Wires 2BA
DH 60M Front Wires ¼" BSF Rear Wires 2BA
30'-0" Span.
3½" Dihedral
3½" Dihedral
1 ¼ BSF Front
1 2BA Rear
1 5/16 BSF Front
1 ¼ BSF Rear
Incidence Wires 2BA
8'9½" Overall Height
5'-3" Track.
Control Jig to be laid across Fuselage with ends resting in slotted blocks on the fuselage side DH 60G resting in fittings on DH 60M.
9'-10"
Stagger 3½"
4'-4⅜" Chord
For Aileron Sprocket setting see separate diagram
23-11" Overall Length
Aileron Sprocket setting with Control Stick central
DH 60G and M Civil 52°
DH 60M RAF 42°
Training Wing Section only.
Black line painted on underside of Plane after preliminary Flight Test
¼" dia BSF Bolt and slotted nut
Shims Pt No H19623 inserted to take up slack
DH 60G - Gipsy II Engines only
Washer plates H 32934 used to adjust incidence of Tail to ½° ± 15 mins positive to Top Longeron
DH 60G Gipsy I Engines only
Washer plates not required Incidence of Tail 1° ± 15 mins positive to Top Longeron
Attachment of Tail Plane Rear Spar DH 60G
DH 60G Method of checking Lateral Level of Fuselage when setting upon Trestles
DH 60M Straight Edge clamped to underside of Top Longerons.
Shim with ¾ dia washers until correct incidence and lateral alignment are obtained
DH 60M Gipsy I and Gipsy II Engs.
Angle of incidence of Tail Plane 1¼° ± 15 mins. positive to Top Longeron
Attachment of Tail Plane Rear Spar DH 60M.

LIMITS FOR RIGGING:

DIHEDRAL	± 10 min.
*INCIDENCE	± ½°
STAGGER	± ½″
AILERON DROOP	¼″ Approx.
LATERAL LEVEL OF TAIL PLANE	± 1°
FIN POST (OUT OF VERTICAL)	⅛″

* The Normal Incidence of Plane is 3½°, but the Actual Incidence is determined by the root fittings which must fall within 3½° ± ½°. The incidence should be constant along the plane. The angle at interplane struts should be rigged to the same angle as measured at root.

Fig. 37.—Rigging instructions for D.H. 60G and D.H. 60M.

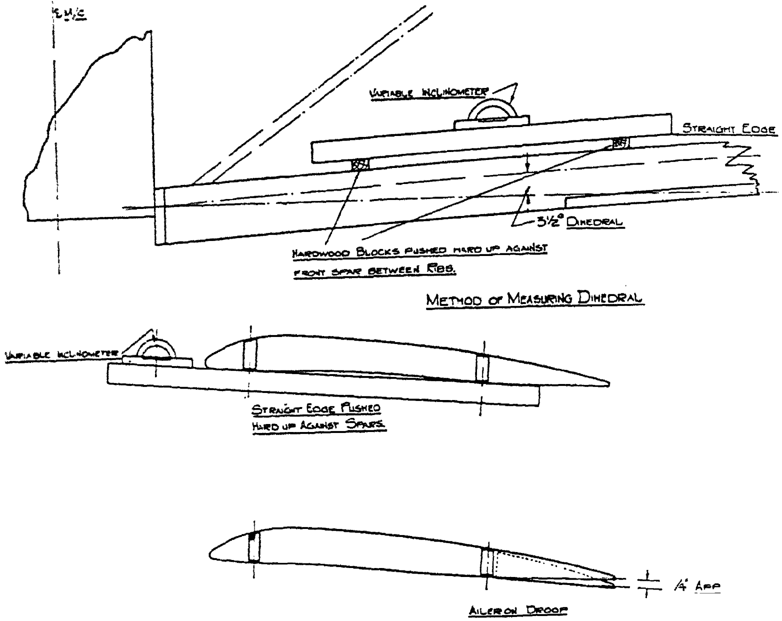

℄ M/C
Variable Inclinometer
Straight Edge
3½° Dihedral
Hardwood Blocks pushed hard up against front spar between Ribs.
Method of Measuring Dihedral
Variable Inclinometer
Straight Edge Pushed Hard up Against Spars.
¼" App
Aileron Droop

Fig. 38.—RIGGING INSTRUCTIONS.

plane. The necessity for this instruction is shown by experience, as in view of the fact that aeroplanes are fitted with different equipment and adapted for various purposes, it is impossible to standardise rigging dimensions and variations such as angles of tail plane are often involved.

Folding the Main Planes

The main planes are designed for folding in order that the aeroplane can be housed in a small shed. When it is desired to fold the planes, the *jury struts must first be fitted in position* between the front spars. The top locking pins should then be pulled out followed by the bottom pins, and afterwards the planes can be allowed to swing back slowly. They should be retained in position by the slip bolts provided for the purpose. To open out the planes the above process should be reversed. When the planes are in position *it is imperative that the locking pins are pushed right home and secured by the straps provided.*

The Differential Aileron Control

Should the angle of the crank lever on the aileron control chain sprocket unit be disarranged for any reason, such as the dismantling and reassembling of planes, care must be taken that this aileron crank lever is positioned as before, *i.e.*, at an angle of 52 degrees to a line parallel to the main plane leading edge. This can be conveniently done by lining up the black marks painted on the under surface of the bottom planes. It is important to see that this angle is the same on both sides of the aeroplane when the control stick is set central, by means of jig supplied.

A droop of approximately $\frac{1}{4}$ in. at the trailing edge should be allowed on the ailerons.

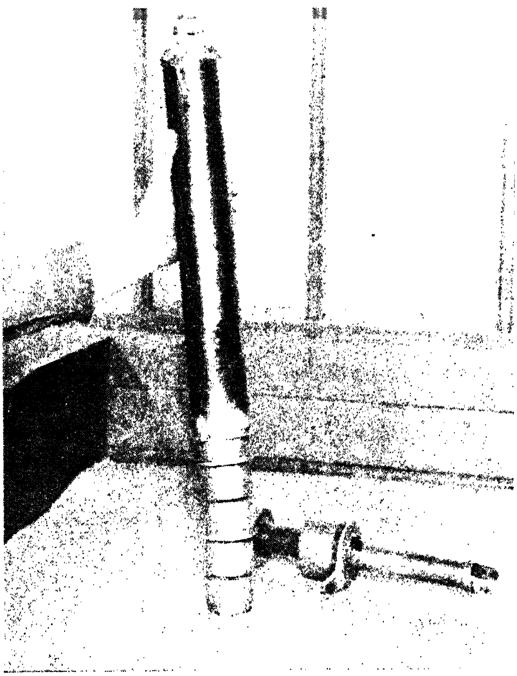


Fig. 39.—DISMANTLING UNDERCARRIAGE LEG (3).

When the bottom casing fitting has been undone and the sliding tube drawn clear, the cylinder is held upright to allow the rubbers and spacers to drop out.

The operating chain on the sprocket is to be set central when the crank lever is as indicated above, and the aileron droop fixed. Any further slight adjustments between the control stick and the aileron gearing can be made on the cable turnbuckles. Also, aileron push rods are adjustable, *but these, once set, should not be altered unless for reasons outlined below.*

If the aeroplane shows a tendency to fly one wing low, first check the rigging of the wing structure and note that the aileron crank lever is correctly set. Should these points be found correct, the trouble may be due to slight warping of aileron spars.

Rectification should be made in the following manner:

(*a*) Disconnect both push rods between the sprocket wheel levers and the aileron levers.

(*b*) Lengthen the push rod on the side which tends to fly low by unscrewing the adjustable end by one turn, shortening the rod on the other side by a corresponding amount.

(*c*) Re-connect the push rods.

If this adjustment proves insufficient to correct the trim of the aeroplane, the operation should be repeated until the fault is overcome. Care should be taken, however, that it is not attempted to put an incorrectly rigged aeroplane in order by this means. It should never be necessary to shorten or lengthen the adjustable push rods by more than two, or at the most three, turns.

DIMENSIONS AND STATISTICS

Span	30 ft. 0 in.
Span folded	9 ft. 10 in.
Length over all	23 ft. 11 in.
Height over all	8 ft. 9½ in.
Cruising speed	85–90 m.p.h.
Stalling speed	40 m.p.h.
Oil consumption	½–1 pint per hour.

Range of Flight and Petrol Consumption

At a true speed of 80 m.p.h. (say 78 m.p.h. on the airspeed indicator at a height of 1,000 feet, or 74 m.p.h. on the airspeed indicator at 5,000 ft. in ordinary temperatures) the petrol consumption varies from 4½ to 5¼ gals. per hour, equivalent to 15–18 m.p.g. in still air, the better figure being obtainable at 5,000 ft. An average consumption at 80 m.p.h. may be taken to be 5 gals. per hour, or approximately 16 m.p.g. in still air. As the throttle is opened, the consumption becomes greater until at full throttle it is 7·5 gals. per hour, or 13·5 m.p.g.

The practical range with full standard tank, taking into account starting and warming up, taxi-ing and the necessity of having some reserve left at the end of the flight, may be taken to be roughly 3¼ hours or 260 miles in still air at a true speed of 80 m.p.h.

N.B. Additional tankage can be provided if required.

	Metal Moth.	Wooden Moth.
*Tare weight (approx.)	980 lbs.	930 lbs.
Pilot and passenger at 160 lbs. each	320 ,,	320 ,,
Petrol (19 gals.)	140 ,,	140 ,,
Oil (2 gals.)	19 ,,	19 ,,
Luggage to (make up max. total weight) (approx.)	291 ,,	341 ,,
MAX. TOTAL WEIGHT. Normal Certificate of Airworthiness	1,750 ,,	1,750 ,,

* Tare weight includes 22 lbs. of movable equipment.

The Certificate of Airworthiness permits the aeroplane to be flown at a fully loaded weight of 1,550 lbs. (aerobatic) and a fully loaded weight of 1,750 lbs. for normal flying.

SPECIAL NOTE. When the aeroplane is used as a single-seater the pilot must occupy the rear cockpit.

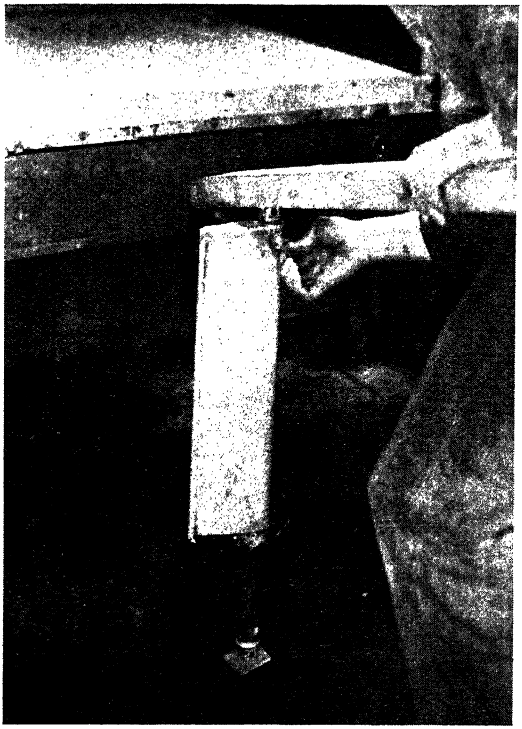


Fig. 40.—Dismantling the steel spring leg (1).
After removing grease bag remove top bolt as shown.

Provision is made for full dual control, which can be connected in a few minutes.

ROUTINE INSPECTION

Before each day's flying:

1. The aeroplane should be generally surveyed for any indications of accidental damage.

. The airscrew should be checked for tightness and inspected for damage such as fatigue or stress, fractures or cracks at boss and blade roots, and blades generally.

. The fabric coverings of all surfaces should be inspected for general condition and holes.

4. The free movement of all controls should be checked.
5. See that engine cowling and luggage locker lid are properly fastened.
6. Inspect tail skid, spring and undercarriage for any signs of abnormal landing stress.
7. Check all four wing locking bolts in position and see jury struts stowed.
8. Clean petrol filter.
9. Run up engine and check each magneto by operating switches.
10. Check oil and petrol and ensure sufficient quantity with a safe margin for journey proposed.

Special Note. After cleaning the petrol filter it is found that there is danger of trapping air, which may affect the petrol flow when next starting the engine. After refitting the filter it is advisable to disconnect the petrol pipe at the carburetter end and allow the petrol to flow until a full bore, with no air bubbles, is obtained. Then connect the pipe to the carburetter whilst the petrol is flowing, thus ensuring that there will be no airlock.

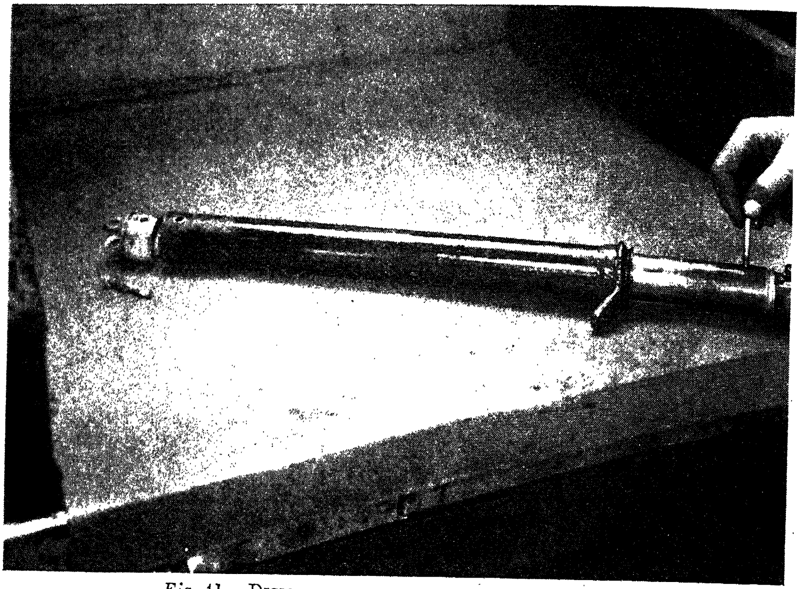


Fig. 41.—DISMANTLING THE STEEL SPRING LEG (2).
Next remove the bottom bolt as here shown.

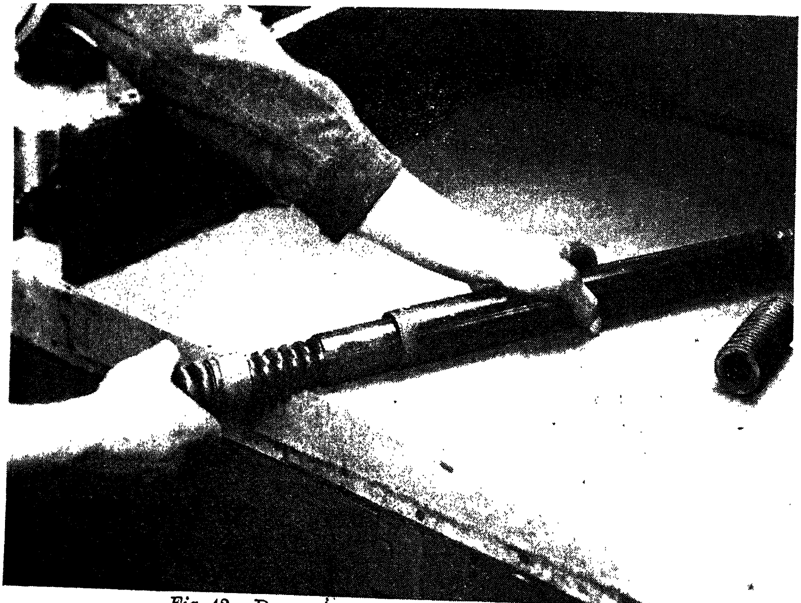


Fig. 42.—DISMANTLING THE STEEL SPRING LEG (3).
Withdrawing the spring unit.

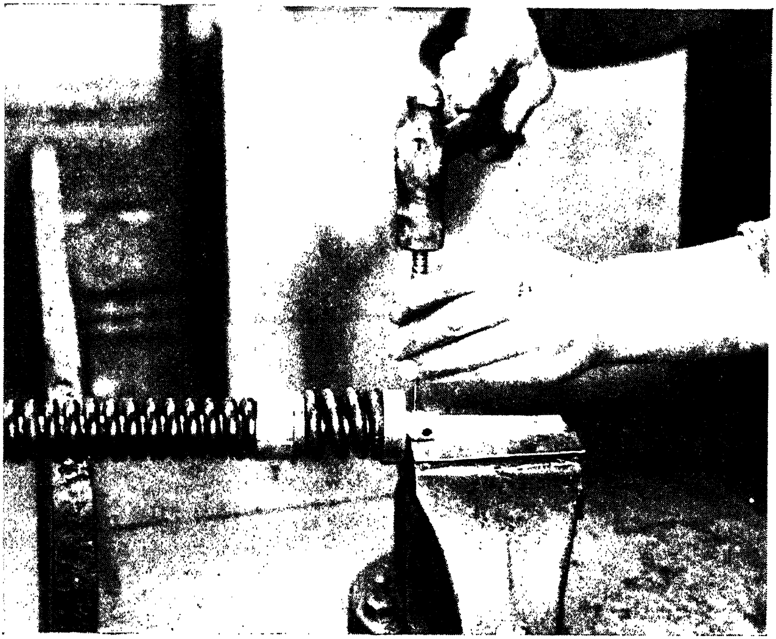


Fig. 43.—DISMANTLING THE STEEL SPRING LEG (4).
Now remove rivet from end spindle as shown.

After a Heavy Landing

1. Lift the aeroplane on tressle with undercarriage clear of ground and inspect wheels, axles, shock absorber legs, the attachment bolts and pins and undercarriage generally.

2. Examine longerons and vertical and diagonal struts in front cockpit where chassis legs and chassis radius rods are attached to the fuselage. The most likely place for damage to occur is where the tie rods which run across the floor of the cockpit pass through the longeron. Look carefully for any split or fracture of the wood at these points ; in the case of fracture get expert advice.

In the case of metal fuselage examine for buckled or dented tubes or broken welding.

3. Try centre section bracing wires. If they are slack, look for the cause of the slackness. It may be that the fittings carrying them have "pulled" or the struts have "bowed." *Do not tension up wires without first ascertaining the cause of the slackness.* Should the wing tip come in contact with the ground heavily, the most likely place for damage to occur is fracture to the spars where interplane struts are attached, or in the case of the bottom rear spar at the point round about the inner aileron hinge. Make right-angle cuts in the fabric at these points and carefully

examine the spars; if there is a fracture, get expert advice, if correct, repair cuts in fabric by sewing and patching.

After each 25 hours' Flying

1. Inspection by ground engineer: external examination of airframe, controls, airscrews, instruments, engine and installation.
2. Check valve clearances.
3. Dismantle, clean and test sparking plugs and set gaps.
4. Clean oil and petrol filters.
5. Remove main and power jets and flush through carburetter.
6. Check contact breaker gaps and clean distributors.
7. Drain oil tank and fill with fresh oil.
8. Check airscrew nuts for tightness.
9. Lubricate in accordance with the oiling diagram.
10. Cleaning as required.
11. Run up engine.

The above schedule is intended to apply when 25 hours' flying is completed in a normal period of time.

If the period is unduly long, additional ground engineer's inspections are advised. The same advice applies should the aeroplane experience rough usage or abnormal conditions, or show symptoms of irregular running.

After every 150 hours' Flying

1. Work as detailed in 25-hour schedule.
2. Top overhaul engine.
3. Examine and clean magnetos.
4. Dismantle and clean carburetter.
5. Take petrol flow at carburetter. This should be at least one quart in 60 seconds.

After every 450 hours' Flying

1. Work as detailed in 25-hour and 150-hour schedules.
2. Remove engine from airframe and completely overhaul.

Annual Overhaul

The airframe must be completely overhauled annually to the satisfaction of the Official Inspection Authority for the renewal of the Certificate of Airworthiness.

Repairing "Moth" Airframe

The next section in this volume deals with the methods of repairing the de Havilland "Moth" airframe, together with notes on the "Moth" seaplane.

REPAIRING "GIPSY MOTH" AIRFRAME

Drawings are available indicating typical methods of repair which are approved by the Air Ministry, and a ground engineer licensed in the appropriate category, can, on satisfying himself that a typical method as shown is applicable to the repairs needed, carry out the work, quoting the drawing in the log book, without further reference to higher authority; but attention is drawn to Air Ministry notice to ground engineers, No. 16 of the year 1932, and in view of its extreme importance on the matter of repairs it will not be out of place to quote it here as follows:—

Manufacture and inspection of aircraft parts and approval of materials for the repair or overhaul of licensed aircraft.

1. Attention is drawn to the requirements of Section V., paragraph 57, sub-paragraph (1) of the Air Navigation Directions, 1932 (A.N.D. 11).

2. (i) The attention of aircraft owners and ground engineers is again drawn to the fact that cases have occurred where

(*a*) defective parts had been replaced by parts manufactured without reference to drawings, the defective part being used as a pattern, or

(*b*) details or components for which no certificate of inspection could be produced had been embodied in an aircraft in respect of which a certificate of airworthiness was current or had been applied for. In the latter cases, parts had been obtained from surplus stocks thrown up by the Royal Air Force, or from various sources other than the manufacturer.

(ii) In circumstances such as those referred to in (i), there is considerable risk of the new part being made to incorrect dimensions and/or of incorrect materials.

(iii) In every case where it is necessary to manufacture any detail or component of an aircraft for which a certificate of airworthiness has been issued or is to be issued or renewed, such replacements must be manufactured and inspected to approved drawings.

(iv) Certification of any repair affecting the safety of an aircraft under paragraph 58, sub-section (1) of the Air Navigation Directions, 1932 (A.N.D. 11), should not be made unless either

(*a*) the replacement part has been approved by the makers of the aircraft.

(*b*) the part has been manufactured and inspected to standard approved drawings (approved repair schemes issued by certain makers coming under this head), or

(*c*) the repair has been approved as a "modification subsequent to the issue of a certificate of airworthiness" under the procedure described in paragraph 35 of A.N.D. 11.

The above conditions will not apply in circumstances covered by the

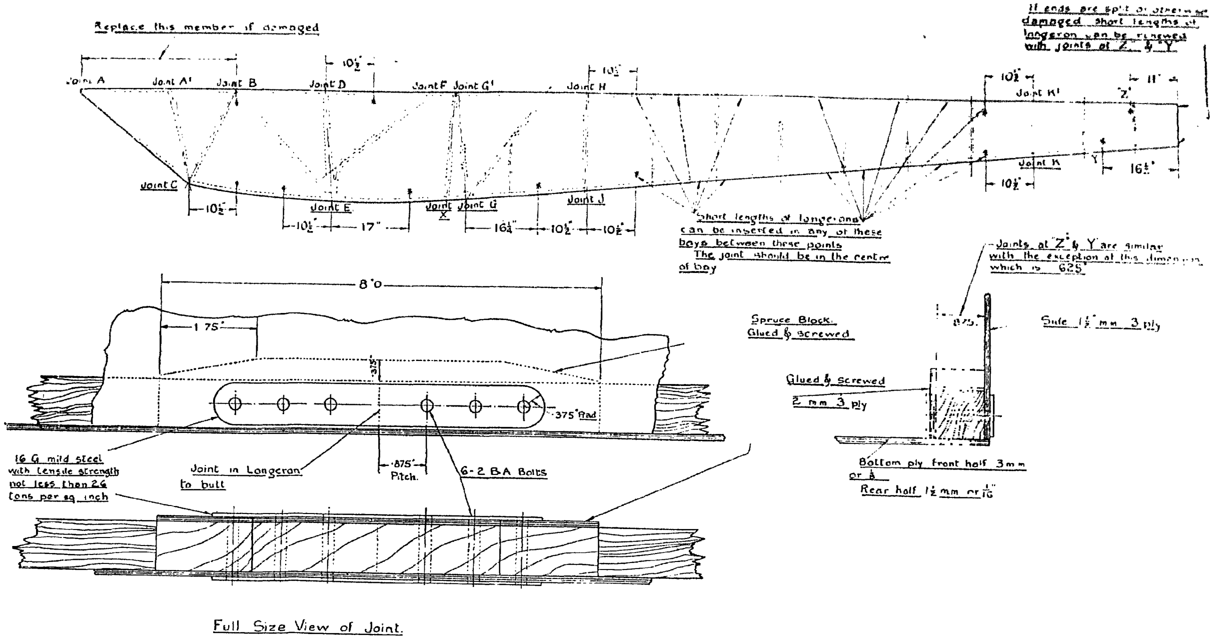

Replace this member if damaged
Joint A
Joint A'
Joint B
Joint D
Joint F
Joint G'
Joint H
Joint K'
'Z'
Joint C
Joint E
Joint X
Joint G
Joint J
Joint K
Y
10½"
10½"
10½"
10½"
17"
16¼"
10½"
10½"
10½"
10½"
11"
16½"
If ends are split or otherwise damaged short lengths of longeron can be renewed with joints at 'Z' & 'Y'
Short lengths of longerons can be inserted in any of these bays between these points
The joint should be in the centre of bay
Joints at 'Z' & 'Y' are similar with the exception of this dimension which is ·625"
8'0
1·75"
·375"
·375" Rad.
·875" Pitch.
6-2 B.A Bolts
Joint in Longeron to butt
16 G mild steel with tensile strength not less than 26 tons per sq. inch
Spruce Block. Glued & screwed
Glued & screwed
2 mm 3 ply
·875"
Side 1½ mm 3 ply
Bottom ply front half 3 mm or ⅛
Rear half 1½ mm or 1/16"
Full Size View of Joint.

Fig. 1.—SHOWING METHOD OF REPAIR TO FUSELAGE OF DE HAVILLAND MOTH (WOODEN CONSTRUCTION).

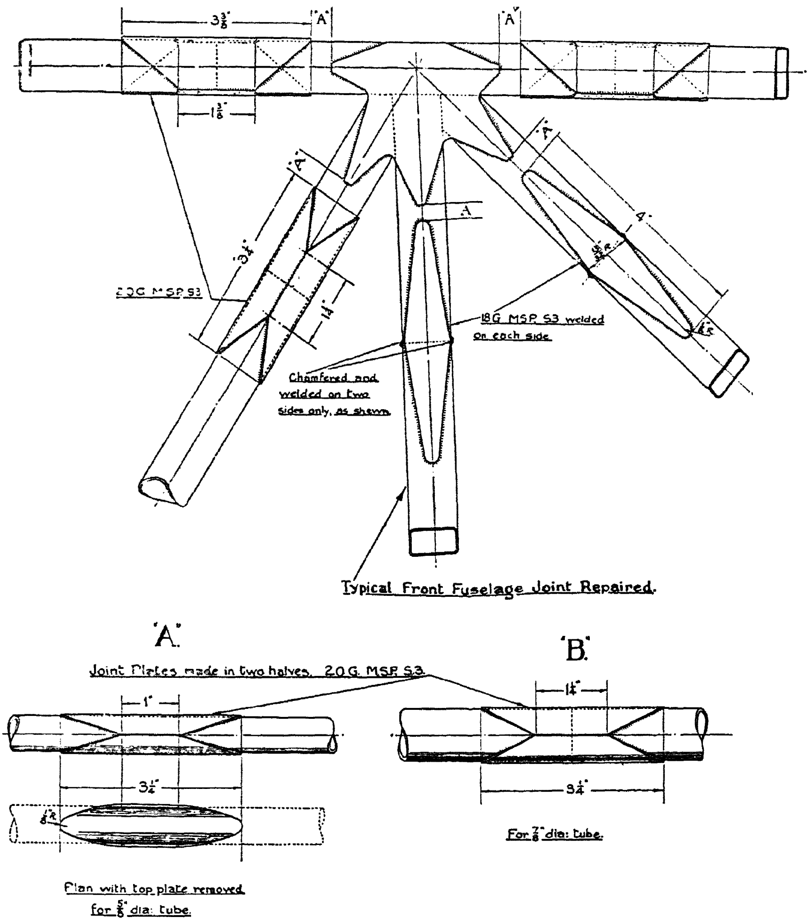

3⅜"
'A'
'A'
1⅜"
'A'
3¼"
1¼"
'A'
4"
A
20G MSP S3
18G MSP S3 welded on each side
Chamfered and welded on two sides only, as shown.
Typical Front Fuselage Joint Repaired.
'A'
'B'
Joint Plates made in two halves. 20G MSP S3
1"
3¼"
Plan with top plate removed for ⅝" dia: tube.
1¼"
3¼"
For ⅞" dia: tube.

Fig. 2A.—WELDED REPAIRS TO FUSELAGE JOINTS AND MEMBERS OF DE HAVILLAND MOTH (see also Fig. 2B).

If one of several tubes meeting at a joint is damaged too close to that joint to enable the individual tube to be repaired, the whole joint must be cut away and remade approximately to typical joints as shown.

If any individual member is damaged so that it can be cut away without interfering with any other members this can be repaired as shown " A," " B," " C," " D."

Damaged tubular cross members which have plugs riveted and sweated in the ends can be replaced by unriveting and unsweating plugs and fitting new tubes of D.T.D. 89A quality, or equivalent tensile strength of 45 tons per square inch.

Important.—Air Ministry Notice to Aircraft Owners and Ground Engineers No. 1 of 1930 states that parts must not be copied, therefore main joint plates or detail drawings of same must be obtained from the manufacturers.

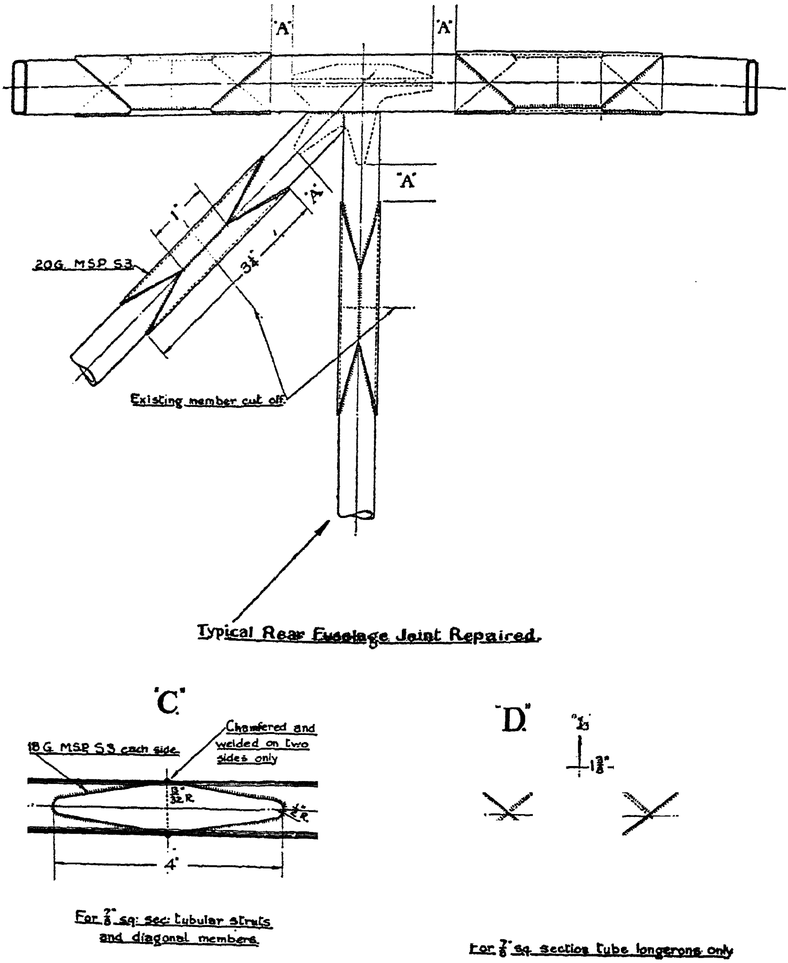

'A'
'A'
'A'
'A'
1"
3¼"
20G. MSP S3
Existing member cut off
Typical Rear Fuselage Joint Repaired.
'C'
18G. MSP S3 each side.
Chamfered and welded on two sides only
3/32" R.
4"
For 7/8" sq. sec. tubular struts and diagonal members.
'D'
1/8"
1 3/8"
For 7/8" sq. section tube longerons only

Fig. 2B.—WELDED REPAIRS TO FUSELAGE JOINTS AND MEMBERS OF DE HAVILLAND MOTH (see also Fig. 2A).

first proviso to paragraph 57; such circumstances could be held to have arisen, for example, if damage was sustained in a region so remote that permanent repair or replacement was impossible.

3. The existence of an inspection stamp is not, in itself, sufficient evidence of approval of materials, details or components; Release Notes and/or Certificates of Material Tests are also required, and these documents should be held available for examination when the aircraft is next reinspected for the renewal of the certificate of airworthiness.

4. Ground Engineers licensed only in Categories "A" and "C" are

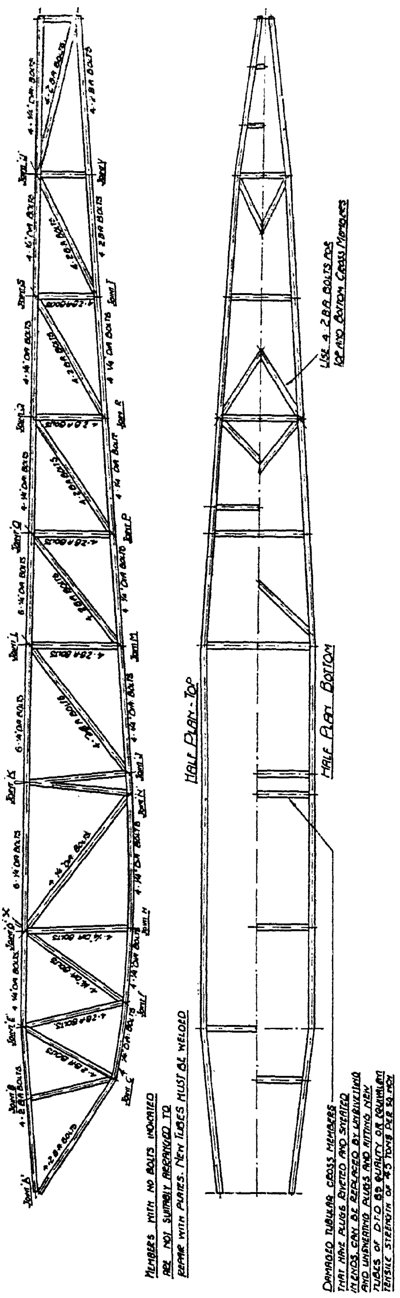

Members with no bolts indicated are not suitably arranged to repair with plates. New tubes must be welded.
Half Plan - Top
Half Plan Bottom
Use 4 2BA bolts for top and bottom cross members
Damaged tubular cross members that have plugs riveted and sweated in ends, can be replaced by unriveting and unsweating plugs and fitting new tubes of D.T.D. 89 quality or equivalent tensile strength of 45 tons per sq. inch

Fig. 3A.—FUSELAGE REPAIRS, BOLTED TYPE TO DE HAVILLAND MOTH.

Unless otherwise stated replacement tubes can be to specification D.T.D. 89 A or T.1, or other tubing having a tensile strength of not less than 35 tons per square inch. Bolts are to be of steel to Air Ministry specifications S.1, or mild steel with tensile strength not less than 35 tons per square inch.

reminded that they are not empowered to certify repairs or overhauls.
26/4/1932, Revised 1/3/1933. (160246/32)

The typical repair drawings available are as follows:

Fig. 1 shows method of repair to fuselage (wooden construction).

Figs. 2A and 2B show the standard approved joints for sections of longerons, struts and cross-members (type 60 M Metal fuselage) where welding facilities are available.

Figs. 3A and 3B show the method of bolted repairs on metal fuselages where welding is not available.

Fig. 4. Method of repairing aileron spar tip where end has been damaged, due to bend being torn off.

Fig. 5. Method of reinforcing rib cappings over spar when split is found across screw hole.

Fig. 6. Method of reinforcing root end of front main plane spar should end shake occur from first bolt hole to end of spar. This repair is permissible provided the shake does not extend beyond the first bolt holes.

Fig. 7 shows the limits of error permissible in assembly.

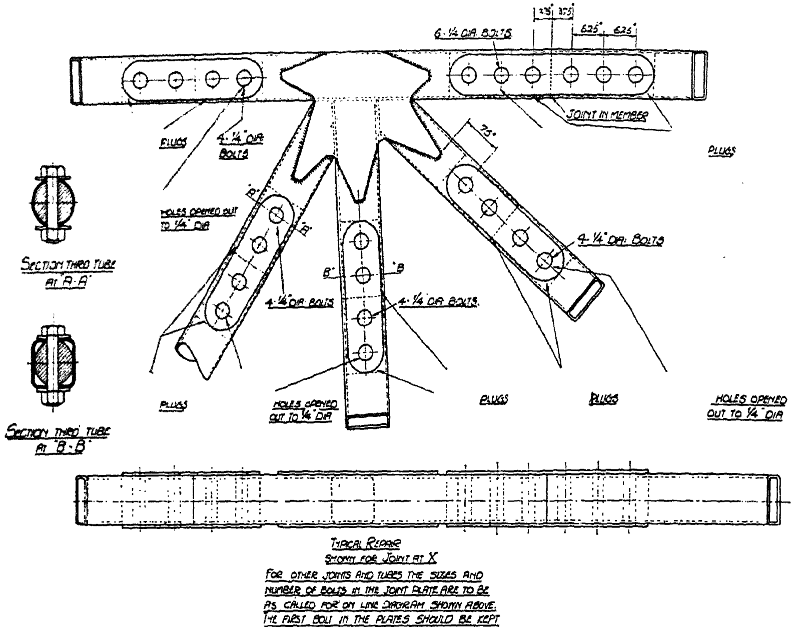

.375" .375"
6·¼ DIA BOLTS
.625" .625"
JOINT IN MEMBER
PLUGS
4·¼" DIA BOLTS
.75"
PLUGS
HOLES OPENED OUT TO ¼" DIA
'B' 'B'
4·¼" DIA BOLTS
SECTION THRO TUBE AT 'A-A'
4·¼" DIA BOLTS
B' 'B
4·¼ DIA BOLTS.
SECTION THRO' TUBE AT 'B-B'
PLUGS
HOLES OPENED OUT TO ¼" DIA
PLUGS
PLUGS
HOLES OPENED OUT TO ¼" DIA
TYPICAL REPAIR
SHOWN FOR JOINT AT X
FOR OTHER JOINTS AND TUBES THE SIZES AND
NUMBER OF BOLTS IN THE JOINT PLATE ARE TO BE
AS CALLED FOR ON LINE DIAGRAM SHOWN ABOVE.
THE FIRST BOLT IN THE PLATES SHOULD BE KEPT

Fig. 3B.—FUSELAGE REPAIRS, BOLTED TYPE, TO DE HAVILLAND MOTH (see also Fig. 3A).

Fuselage Repairs : 60 G (Wooden Construction)

Fig. 1 shows the standard approved joint for sections of longerons (types 60, 60 X and 60 G wood construction) and the positions are indicated where it is permissible to make these joints.

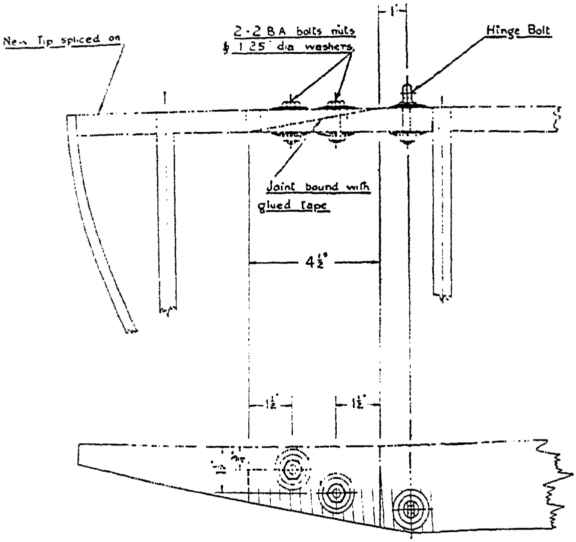
This indicates in a particularly clear way the method of inserting new sections of longeron.

The positions where these joints are permissible is shown and the method of making joints in the ply-covering should the necessity of incorporating new panels arise. Care should be taken to ensure that these joints are not left proud in a position where they may touch the pilot's boot.

Should the fuselage be damaged to such a degree that it cannot be repaired to this drawing, a new component or section must be fitted. The fuselage is jointed with fishplates at a point just behind the pilot's cockpit and jig-built sections of the fuselage can be obtained and easily fitted and aligned to the remaining sound portion, as follows : Front fuselage bare, rear fuselage bare, front fuselage sides, rear fuselage sides, front fuselage bottom, rear fuselage bottom, front cowling over cockpits and rear fuselage decking.

Fuselage Repairs : 60 M (Metal Construction)

Welded Repairs. The square and round tubing used throughout the fuselage is high-grade low carbon mild steel, specially chosen because of its suitability for welding. For replacement tubes and minor repairs the special tubing can be obtained from the constructor. It is absolutely forbidden to use stainless or steel tube to specifications T.1, T.5, T.2, or any type of steel containing more than ·3 per cent. carbon.



g. 4.—REPAIR OF AILERON SPAR TIP (D.H. MOTH).

The strap plates are made of mild steel plate but if only tubing is available the flat plate can be cut from tubing and flattened. They should preferably be normalised after the operation, but if the necessary plant is not available this process can be dispensed with.

The diagram shows alternative methods of joining a new member. It is important that joints should not be further than 1½ in. from the extreme welded part of the main joint. Welding in the middle two-thirds of any struts is forbidden, as the strength would be reduced by approximately 40 per cent.

Before cutting out a damaged member preparatory to replacement, the aeroplane should be jacked up in such a manner that when the member is cut there is no possibility of the structure sagging: should this happen, other members will be seriously overloaded and possibly damaged. For example, assuming that it is necessary to repair a bottom longeron, to relieve the point of any load it would be necessary to use four trestles or other temporary means to support the part of the fuselage—each side of the part to be repaired. These should be adjusted so that they just take the load. Every section must be considered on its merits and means taken to give suitable support.

In the case of one longeron only being involved it would simply be necessary to level the fuselage in both directions and plumb the stern post. Should two longerons be involved, it would also be necessary to drop plumb bobs, and with the aid of a line stretched under the fuselage check the fuselage for alignment in plan view.

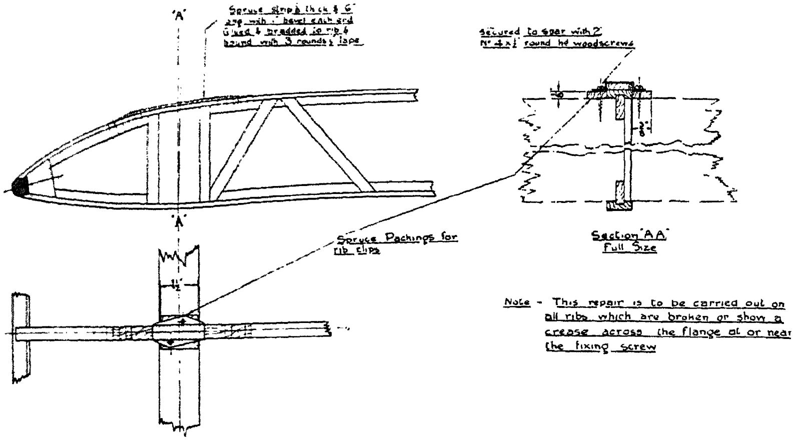

'A'
Spruce strip ⅛ thick & 6" lng with ¼" bevel each end Glued & bradded to rib & bound with 3 rounds ½" tape
Secured to spar with 2 No 4 x ½" round hd woodscrews
'A'
Spruce Packings for rib clips
Section 'AA' Full Size
Note - This repair is to be carried out on all ribs which are broken or show a crease across the flange at or near the fixing screw

Fig. 5.—REPAIR TO RIB, SHOWING FIXING OF RIB CLIP (D.H. MOTH).

Reference to the repair diagram shows that the sleeves and plates are part numbered. These can be obtained from the constructors, but sufficient directions are given for the repairer to make the fittings, if this is more convenient.

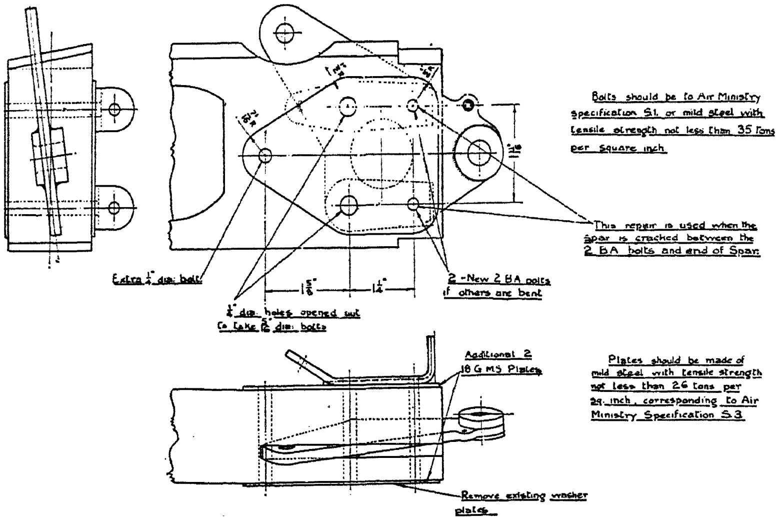
After cutting out the damaged member, the adjacent portion of the member should be well cleaned by scraping and by emery paper so that a clean surface is available for welding.

The new member should be shorter than the gap to allow for expansion when welding. A clearance of $\frac{1}{16}$ in. should be allowed at all jointing places. Before inserting the new member, the side plates can in most cases be tack-welded on. This will facilitate handling and lining up, as the free ends of the plates can be held by clamps to the main structure while a few preliminary tack-welds are made. After removal of the clamps the welding can be completed.

It is important to seal the edges of the tubes not covered by the welding of the plates, so as to prevent ingress of moisture and subsequent deterioration.

Should a complete joint be involved in the repair this should be built up on the bench in order that the mass of welding in forming the junction of the various struts can be completed before being introduced to the main structure. This should then be fitted in position, allowing a $\frac{1}{16}$ in. gap at all jointing places. The whole would then be positioned with the joint plates lightly clamped and tack-welded. Then check alignment and complete weld on struts and diagonals. Make final check on alignment and complete welds on longeron joints.

The above procedure should be carefully noted as the natural inclination would be to get the main longeron into position first and then fit the struts and diagonals, but experience has shown that this mass of welding


Bolts should be to Air Ministry specification S1. or mild steel with tensile strength not less than 35 Tons per Square inch
This repair is used when the spar is cracked between the 2 BA bolts and end of Spar.
Extra ¼" dia. bolt
1⅝"
1¼"
2 -New 2 BA bolts if others are bent
¼" dia. holes opened out to take 5/16" dia. bolts
Additional 2 18 G MS Plates
Plates should be made of mild steel with tensile strength not less than 26 tons per sq. inch, corresponding to Air Ministry Specification S3
Remove existing washer plates

ig. 6.—REPAIR TO BOTTOM FRONT SPAR (D.H. MOTH).

to the longeron, which has already become a part of the structure, will lead to serious difficulties in alignment.

Dents. Dents found in adjacent tubes when a member has been cut out can be knocked out by suitably shaped drifts, which can be improvised from any available material.

In other members smooth dents, without showing cracks in the material, can be ignored if their depth does not exceed ·05 in. for ⅞ in. and 1 in. sized members, and one half this amount for ⅝ in. members. If the dent exceeds these amounts the tube must be replaced unless it occurs within one-quarter length of the strut from the joint; in this case a sleeve repair type A, B or D can be welded on as shown in Figs. 2A and 2B.

Bowing of Members. Members bowed up to 1-600th of the length from joint to joint need not be straightened, but if the deviation from straightness is greater than this, but less than ⅜ in., then the member can be straightened by placing a stiff length of timber on the concave side of the bowing and pulling the tube towards it by means of a suitable cramp. A length of wood should be placed between the tube and the cramp to avoid any local damage. After straightening, examine the ends of tube for cracks. Members bowed more than ⅜ in. or showing cracks anywhere should be replaced.

Bolted Repairs. In some cases temporary repairs can be carried out by plugging the members and joining in the new section by means of bolted cover plates. At the first opportunity a welded repair should replace the bolted type. Particulars of the plates and the number of bolts necessary for any case are shown in Fig. 3.

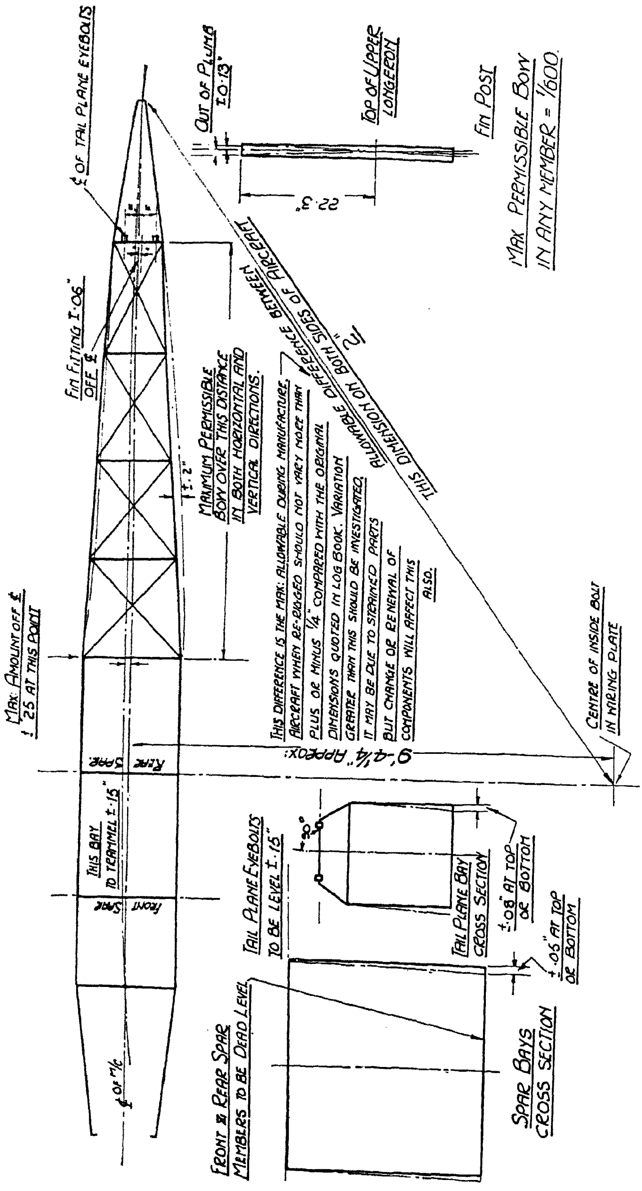

℄ OF TAIL PLANE EYEBOLTS
OUT OF PLUMB ±0·13"
TOP OF UPPER LONGERON
FIN POST
MAX PERMISSIBLE BOW IN ANY MEMBER = 1/600
22·3"
FIN FITTING ±·06" OFF ℄
MAXIMUM PERMISSIBLE BOW OVER THIS DISTANCE IN BOTH HORIZONTAL AND VERTICAL DIRECTIONS.
±·2"
THIS DIMENSION ON BOTH SIDES OF AIRCRAFT
ALLOWABLE DIFFERENCE BETWEEN ·2"
THIS DIFFERENCE IS THE MAX: ALLOWABLE DURING MANUFACTURE. AIRCRAFT WHEN RE-RIGGED SHOULD NOT VARY MORE THAN PLUS OR MINUS 1/4" COMPARED WITH THE ORIGINAL DIMENSIONS QUOTED IN LOG BOOK. VARIATION GREATER THAN THIS SHOULD BE INVESTIGATED, IT MAY BE DUE TO STRAINED PARTS BUT CHANGE OR RENEWAL OF COMPONENTS WILL AFFECT THIS ALSO.
MAX: AMOUNT OFF ℄ ±·25 AT THIS POINT
CENTRE OF INSIDE BOLT IN WIRING PLATE
9'-4¼" APPROX:
REAR SPAR
THIS BAY TO TRAMMEL ±·15"
FRONT SPAR
TAIL PLANE EYEBOLTS TO BE LEVEL ±·15"
30°
TAIL PLANE BAY CROSS SECTION
±·08" AT TOP OR BOTTOM
±·05" AT TOP OR BOTTOM
SPAR BAYS CROSS SECTION
FRONT & REAR SPAR MEMBERS TO BE DEAD LEVEL
℄ OF M/C

Fig. 7.—TOLERANCES FOR METAL FUSELAGE REQUIRED OWING TO WELDING DISTORTION (D.H. MOTH).

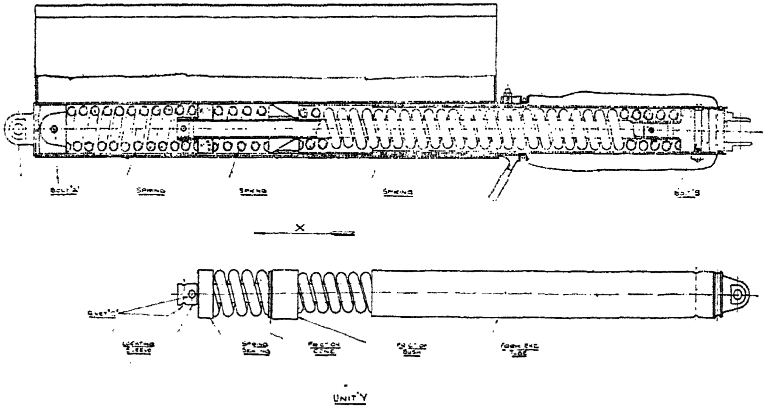


Fig. 8.—UNDERCARRIAGE LEG (COMPRESSION SPRING).
Gipsy Moth, Moth Trainer, Moth Major and Tiger Moth.

Wing Structure Repair

Spars. It is impossible to generalise on repairs to spars caused by accidental damage, as the extent and position vary in all cases.

A bruise or small piece splintered or torn off by contact with obstructions can be usually repaired or the damaged section stiffened up so as to nullify the weakening effect of the damage.

The constructors will prepare at a small charge an approved repair scheme to cover any particular case of spar damage if a repair is feasible. Full particulars and sketches should be sent showing the form and extent of the damage, as well as stating the cause, and quoting the aeroplane type and registration number.

Spar Tips. Wing tips or main rear spars and aileron spars can be repaired if the damage does not run into the spindled portion, but it has been observed that if the wing tip hits the ground sufficiently hard enough to break it, then it is probable that damage may also be found elsewhere and the plane should be opened up to enable a thorough examination of the spar to be made. In particular, look at the end fittings and on top of the spar just at the ends of the interplane strut packings. At the latter points compression shakes may be found; if so, the spar should be replaced.

Ribs. Ribs can be supplied in sections to be finally glued up when inserting in the wing, or new nose or tail pieces can be added by joining the cappings. Local cutting of the fabric only is necessary.

Leading and Trailing Edges and Bends. These can be repaired by splicing in new sections for wooden parts and by the insertion of new sections jointed by plugs for metal parts.

Undercarriage Leg (Rubber Spring Type)

The compression rubbers in undercarriage legs are liable to deteriorate in service.

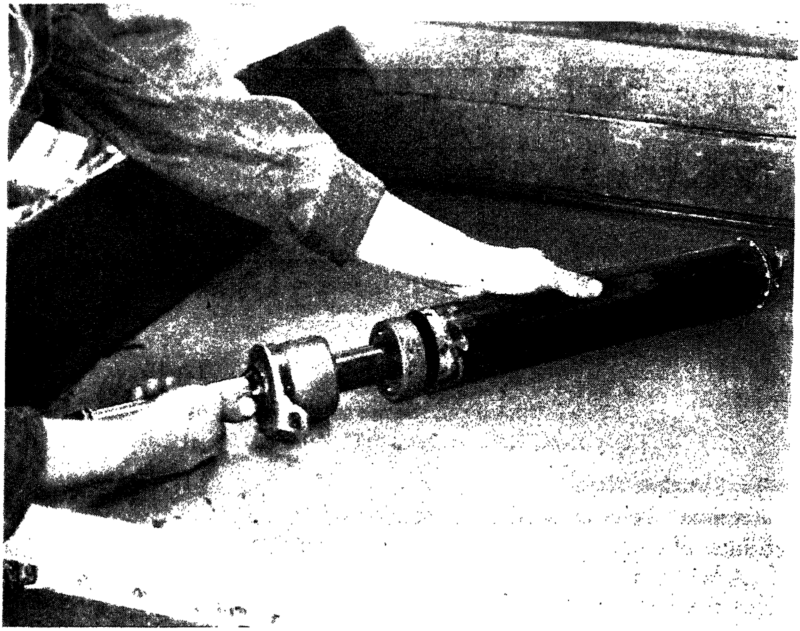


Fig. 9.—UNDERCARRIAGE LEG (RUBBER SPRUNG TYPE).

The leg is here shown on the bench with the bottom casing fitting undone and the sliding tube just drawn clear.

In order to ensure that the deterioration has not occurred to such an extent as to render the legs ineffective, the following procedure is to be adopted :—

(*a*) The aeroplane is to be jacked up until the landing wheels are off the ground and the free movement or up and down play of each unloaded leg is to be measured.

(*b*) Replacement of rubbers is to be made, where free movement exceeds the limit laid down.

In the case of the " Moth " this limit is set at ·75 in. and if exceeded the following action should be taken :—

Dismantle leg and it will be found 8 compression rubbers are fitted. If the rubbers have compressed to 1⅝ in. thick a practice has been made of changing half the total number.

Should, however, they measure less than 1⅝ in. all the rubbers should be replaced by new ones.

Undercarriage Leg (Steel Spring Type)

The assembly of this type leg is shown in Fig. 8. The initial compression of the springs of a new assembly is approximately ·4 in. *i.e.*, if bolt " A " is removed the plug end will spring out this amount.

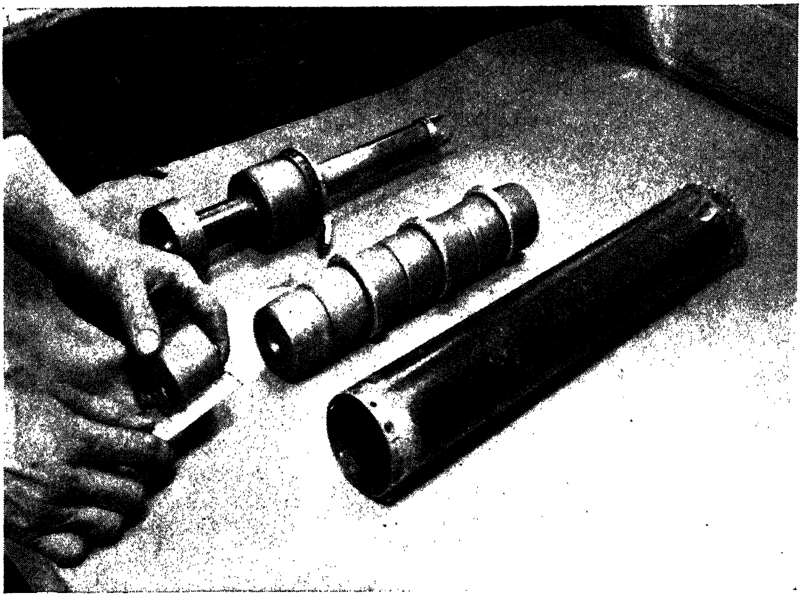


Fig. 10.—UNDERCARRIAGE LEG (RUBBER SPRUNG TYPE).

The casing, sliding tube and rubbers laid out on the bench and one rubber being measured for thickness.

The springs, however, take a certain amount of permanent set during service which will be indicated by the free movement which will be felt when wheels are lifted clear of ground and axle is lifted.

If this free play is about $\frac{1}{8}$ in., it is of little importance, but the leg should be dismantled and the springs washered up to reduce this. If the free play is more than $\frac{1}{8}$ in. the springs should be examined and measured up and the bad one or more replaced by new. The drawing lengths of the new springs are as follows :—

Part No. 45485, Alternative 60394 . . .	5·1 in.
Part No. 45484, Alternative 60393 . . .	2·1 in.
Part No. 45486, Alternative none . . .	14 in.

To enable the internal mechanism to be examined during overhaul or possibly to replace broken spring, the procedure for dismantling is as follows :—

Remove grease bag.

Top bolt " A " should now be removed. This necessitates end force on the leg. The bolt can now be tapped out. Remove leg from loading mechanism. The plug can now be removed, also the spring.

Remove bottom bolt " B."

Withdraw unit " Y " through top end, *i.e.*, in direction of arrow " X."

To dissemble unit " Y " (see Fig. 8).

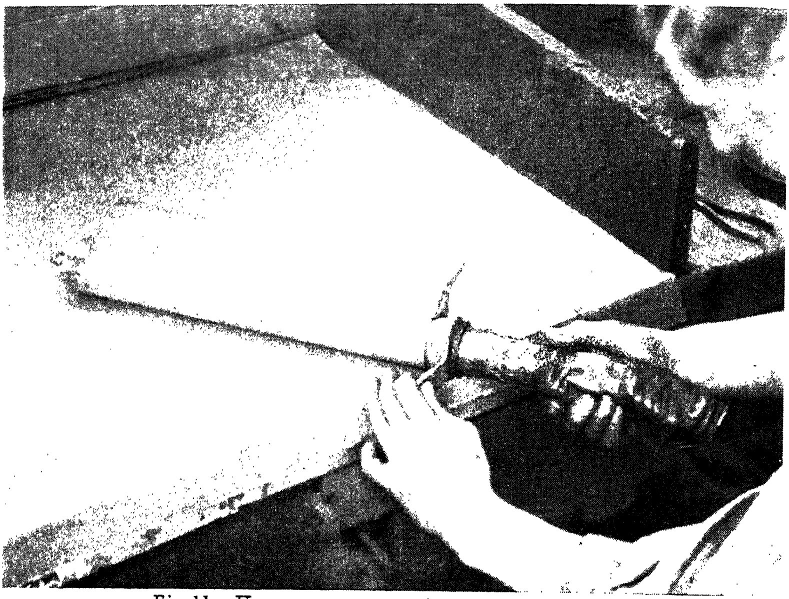


Fig. 11.—UNDERCARRIAGE LEG (STEEL SPRING TYPE).
Showing method of removing the grease bag.

Rivets " C " in the locating sleeve must now be removed. To enable this to be done end load must be applied, as before, owing to pressure due to initial compression, which is approximately ·15 in. When rivets are removed, the locating sleeve, spring seating, small spring, friction cone, friction brush and large spring can be removed.

Reverse the operation to reassemble. Grease parts well but do not fill leg with grease.

REPLACEABLE COMPONENTS

To facilitate repair and replacements, the front fuselage sides, rear fuselage sides, front fuselage floor, rear fuselage bottom, cowling over cockpits, decking over rear fuselage are all obtainable as jig-made units.

THE "MOTH" SEAPLANE

Assembly of the Float Undercarriage

1. *Line up Seaplane* sufficiently high to receive floats with the minimum ground clearance.

2. *Set up Floats* under seaplane. Care need not be exercised in placing port float to port, as they are interchangeable by reversing trough cover plates, remove trough cover plates and release securing pins and bolts from bearing blocks and caps (front caps hinge forward and the rear ones aft), take front cross tube (complete with fairing, sleeves, double

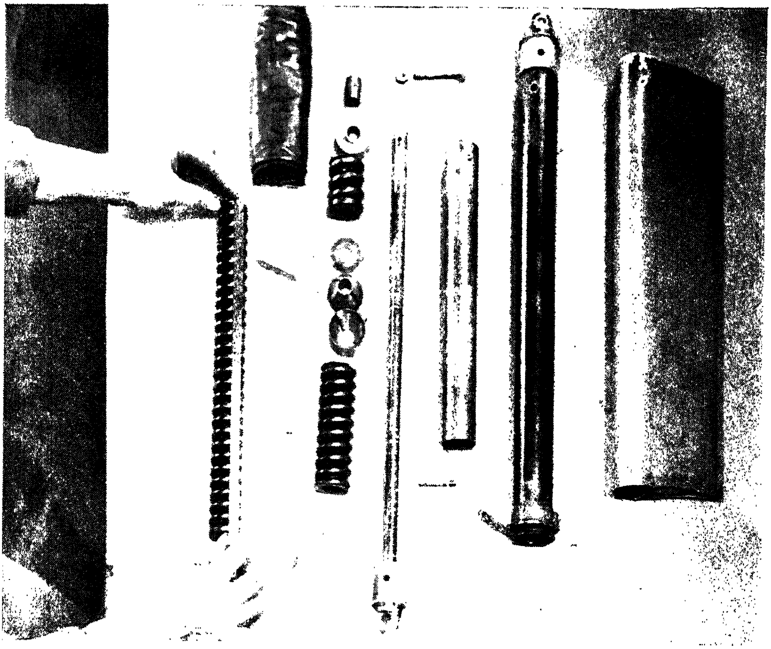


Fig. 12.—THE COMPONENTS OF THE STEEL SPRING LEG LAID OUT ON THE BENCH. With springs laid out in their relative positions so that they can be checked for length.

wire-holder and front strut attachment), place in bearing blocks, replace caps, line up pin holes in cross tubes with pin holes in cap, drop in pins and secure by locking wire. The foregoing procedure applies also to rear cross tube, all wire-holders, etc., being complete on the cross tube.

3. *Setting up Struts.* All struts are complete with their fixing bolts, nuts and split pins, ready to fit direct to their respective fuselage and float attachment fittings. Merely remove bolts, etc., offer up to seaplane and replace fixings. On the two front struts an air vent pipe is fitted, at the lower ends of which connections will be found for securing to adaptors on the forward side of front trough on each float. At the upper ends of the two intermediate struts a side bracing wire-holder will be found.

4. *Fixing Front Cross Bracing Wires.* The whole bracing is complete as a unit, comprising marrying plate, acorn, wires, fork ends, pins and split pins. Remove split pins and pins, ease lock nuts at fork ends, then connect fork ends to their respective wire-holders and replace pins and split pins. Tighten up wires as required and secure by lock nuts. The foregoing procedure applies also to the rear cross bracing wires.

5. *Fixing Side Cross Bracing Wires.* Two wires port and two wires starboard, each complete with fork ends, pins and split pins. The same procedure as in Item (4) applies for fitting and fixing.

Maintenance

The floats will prove both easy and economical of upkeep, provided that the small amount of attention required is given in a systematic manner.

A point should be made of removing all inspection covers at regular intervals, this period depending somewhat on the general condition of the floats, the amount of leakage developed under continued service, and also to some extent on the salinity of the water. The period adopted for floats in service is about four weeks.

After removal of covers, any leakage water should be removed by use of the drain plugs, any deposit of salt removed, the wetted surfaces swabbed with fresh water, dried, repainted, and regreased.

Before replacing inspection covers, well grease the faying surfaces.

Abrasions of external surfaces should be treated quickly by cleaning, carefully drying and applying first one coat of Rylard's white undercoating, and, when dry, one coat of Rylard's white finishing enamel.

When withdrawn from the water the seaplane should be docked *only* on the approved type of trolley and all parts in contact with the floats must be covered with grease.

Steel tubes or fittings in contact with floats should be kept well greased, japanned or painted and free from rust. This also applies to strut ends and bracing wires with regard to grease.

Repair

If floats become damaged through any cause (an actual hole need only be repaired, and buckles and indentations have no deleterious effect on the floats, providing they are of a not too serious nature, and at any suitable period and with care can be tapped out) only duralumin sheet (preferably " anodically " treated) and rivets should be used for patching.

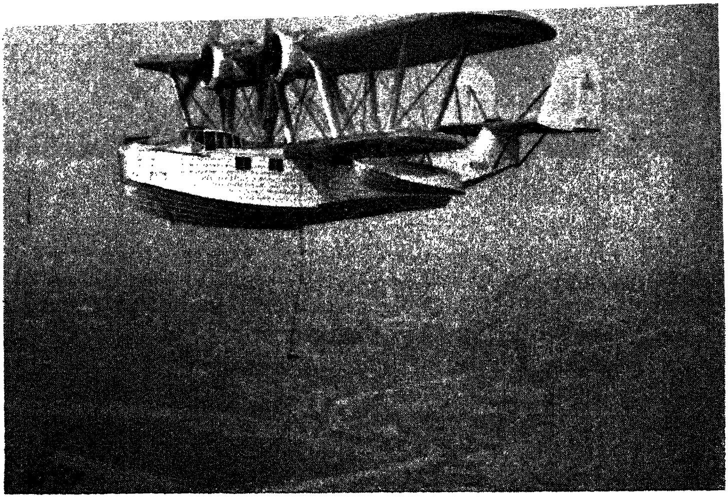
Before affixing patches, the hole should be straightened out—all rough and jagged edges removed, and the faying surfaces should be well cleaned with a reliable paint remover, washed with fresh water and dried. The patches should be fitted, one internally and one externally, well bedded down on Rylard's white enamel. (Thoroughly paint contact or faying surfaces before riveting up). Rivet holes should be drilled to take $\frac{1}{8}$ in. diameter rivets, $\frac{1}{2}$ in. pitch, $\frac{1}{4}$ in. from edge of plates, and forming not less than $\frac{1}{2}$ in. wide lap with sandwiched plate; remove all burrs from drilled holes before riveting.

When repairs are completed, wash down with fresh water, thoroughly dry, and apply one coat of Rylard's white undercoating, and, when dry, follow with one coat of Rylard's white finishing enamel, on external surfaces, and internally one coat of Rylard's white undercoating.

Steel fittings needing replacement should, if possible, be " sheradised " or " zinc " coated, but should in any case be well japanned on the surfaces in contact.

INSPECTION OF THE FLYING BOAT AND ITS ENGINES BEFORE FLIGHT

By R. H. LONGE, *Inspector*, *Saunders-Roe Ltd.*



SARO "LONDON" FLYING BOAT.

Inspection Sequence

)e duplicated
at the 10 hours' period, in addition to other i
less:
attention, and so on, up to the 360

How Service Route Affects Schedules

The nature of the work or route upon which the boat is employed will decide, to a great extent, where particular watch should be kept for wear or failure. For instance, a flying boat employed on short routes with frequent landings will require a constant check on the hull structure and engine mountings, whereas long journeys with few landings will mean less work thrown on the structure and more on the flying control system and surfaces. This does not mean, however, that any one part of the airframe or engines will be neglected, as all details must have the closest examination and the attitude of the inspector should be of "always looking for trouble."

Inspection Groups

The inspection is made in a methodical manner, sub-dividing the aircraft into a number of groups, completing the inspection of one before passing to the next. (See also p. 59.)

Manufacturers' Approved Repair Schemes

All points requiring attention can be jotted down in a note-book, and ticked off when rectified. The rectification can be made either during the inspection or else when the latter is complete. Whatever system is adopted, it should not be varied, otherwise it may result in some point being overlooked, with dangerous results to both pilot and crew, or passengers. It should be remembered, when carrying out repairs to the airframe or engines, that these must conform to the approved repair schemes issued by the manufacturers, unless of a minor character. This requirement is detailed in Air Navigation Directions.

Emergency Repairs

In carrying out temporary repairs when the correct material is not available, it is always advisable to fit a plate or section of heavier diameter or gauge than the original, rather than lighter. Also a stainless steel bolt should not be replaced by one of mild steel, whereas the reverse would be quite safe. This, of course, is due to the difference in tensile strength of the two materials, and is of vital importance if the bolt in question is at an engine mounting attachment fitting or at some heavily stressed point in the hull structure.

Approved repair schemes usually cover the fitting of oversize bolts and hinge pins, either + ·010 in. or + ·015 in., and oversize reamers are available for use with these bolts. When an oversize bolt is needed, the fitting or fork end should not be reamed whilst the joint is under load, as, obviously, a true hole will not be obtained. When no repair scheme is available, discretion should be used, as there is a danger of weakening the fitting by leaving insufficient material around the hole when enlarged.

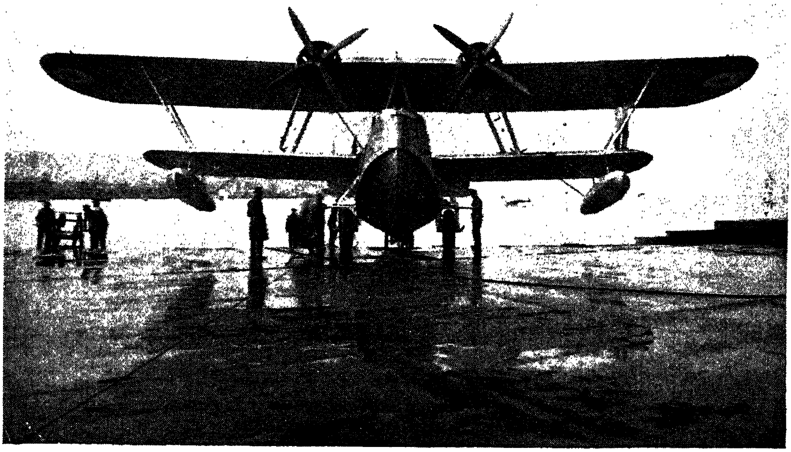


Fig. 2.—THE AEROPLANE BEING HAULED UP THE SLIPWAY ON BEACHING CHASSIS.

Inspection at Groups for Flying Boats

As previously mentioned, the flying boat should be divided into inspectional groups on the following lines :—

1. The hull structure, including internal and external plating; all frames, intercostals and stiffeners; keelson and beaching chassis attachments and main plane attachment fittings.
2. Stabilisers or floats and their support struts.
3. Main plane or planes, struts and bracing wires.
4. Tail unit.
5. Control surfaces.
6. Flying control and engine control systems.
7. Instruments.
8. Internal equipment.
9. Marine equipment.
10. Fuel and oil systems.
11. Engine mountings, cowling, townend rings and exhaust systems.
12. Engines and airscrews.
13. Starting system.
14. E/L. and W/T. equipment.

The pilot's report for the previous flight should be obtained, as this

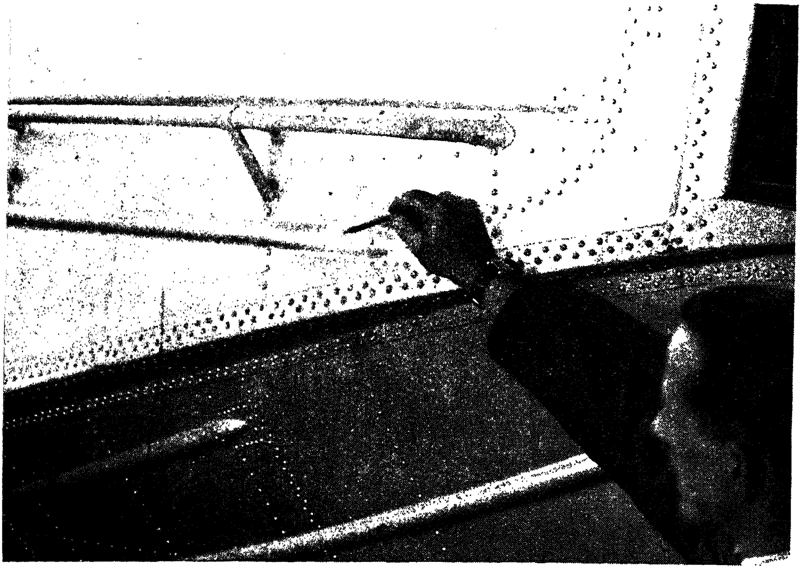


Fig. 3.—INSPECTION OF THE HULL.

The deformation indicated is typical of that caused by the gunwales of dinghies and motor boats and is superficial only, as it is between the main frames.

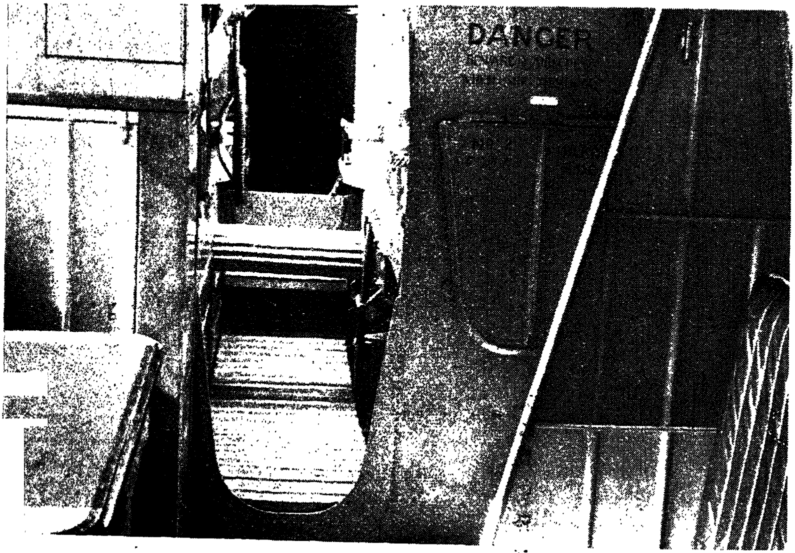


Fig. 4.—THE SWASHBOARD IN ITS STOWAGE.

It should be tried in the lower portion of the bulkhead, for being a good fit.

assists in carrying out the daily inspection. Any defect developing in the flying boat should be traced to its cause. in addition to being rectified.

Systematic Inspection

If the flying boat is moored, the external inspection will have to be made from a dinghy or motor boat.

The Hull

The hull should first be checked from both the bow and the stern for "fair lines." Any local departure should be investigated and particular attention should be paid to the region of the main hatch near the water-line. Damage may be caused here by the gunwales of motor boats when transferring passengers or crew. Local indentations between main frames are not serious and do not affect the efficiency of the boat, but when they occur at the point of attachment of a frame the latter should be inspected from the interior of the hull.

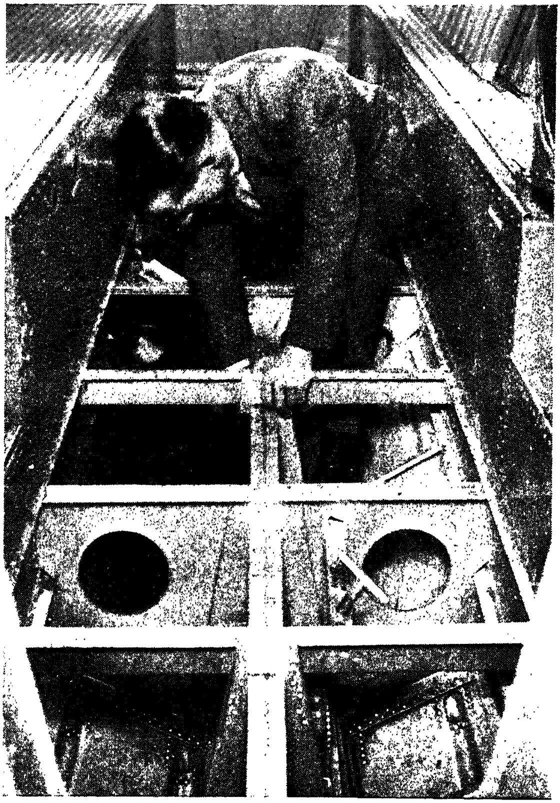


Fig. 5.—THE KEELSON AND FRAMES.

The floorboards have been removed and the keelson and frames are being closely examined for buckling. The main step drain handle is seen at this point.

Plating and Handrails

The plating generally should be examined for corrosion, particularly around rivets and plate laps, and, if found, should be checked in its early stages. Handrails, when these are fitted, and mooring bollards, should be inspected for security of attachment, and all hatches and their locking devices tried for freedom of operation.

Any deformation of the hull deck plating will show up by sighting along from a point at the bow towards the stern.

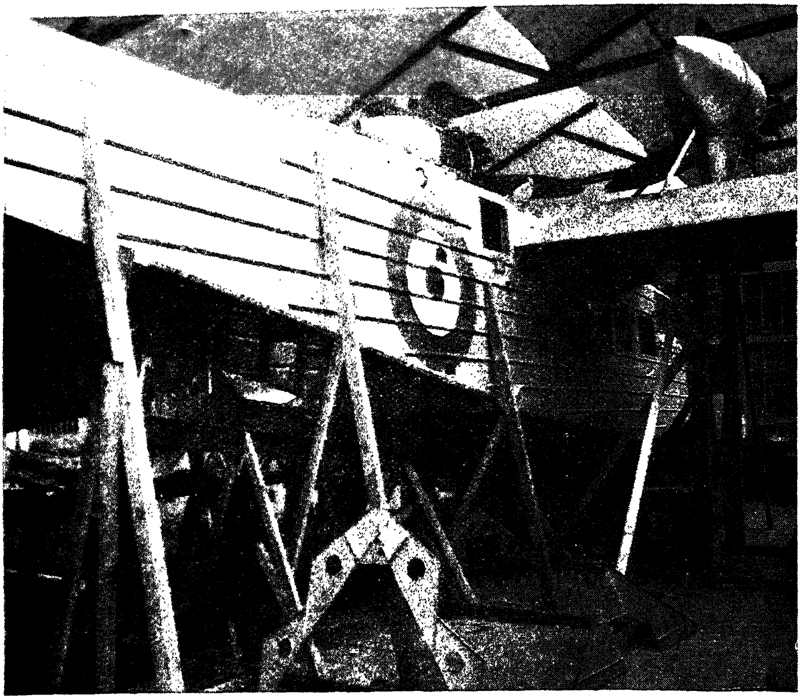


Fig. 6.—THE SARO "CLOUD" AMPHIBIAN (TWO 340 H.P. SERVAL I. ENGINES). Showing section of keelson, plating and frames being renewed.

Windows

All cabin and saloon windows should be inspected for being secure and watertight, and if emergency windows are fitted these must have their quick release gear kept in sound condition. Window framing in the control cabin, if of the welded tube type, should be checked for cracks around the welding and at gusset plates, and all sliding or adjustable windows tried for freedom.

Bulkhead Drains

All bulkhead drains should then be opened, allowing any accumulation of water in the bilge to drain down to the main step, afterwards pumping this overboard by means of the bilge pump. When an auxiliary power unit is fitted to the flying boat, a bilge pump is incorporated in this unit, but on smaller boats the pump is hand operated. If possible, the bilge should then be flushed through with fresh water from both bow and stern. After doing this, all bulkhead drains should be closed.

Keelson and Frames

In making the internal inspection particular attention should be paid to the keelson and frames at the forward planing bottom for signs of damage or buckling. This, of course, cannot be seen except by making an internal inspection below the floor boards when the flying boat is moored.

When upholstery is fitted, the main frames are obscured but the external condition of the plating will be a good guide

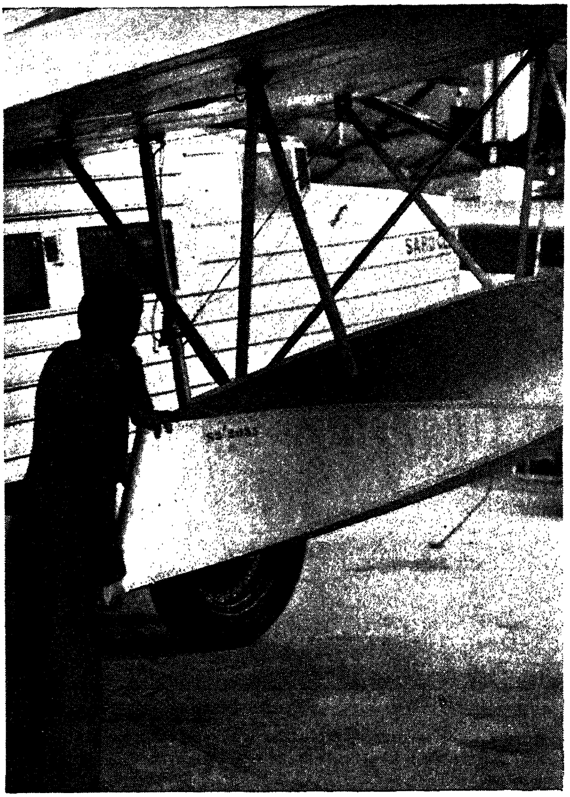


Fig. 7.—FLOAT SUPPORTS.

Detecting wear at float struts by lifting on toe and heel of float.

Wing Stabilisers

On completing a general inspection of the hull structure, the wing stabilisers or floats should be examined for damage to the skin plating and for "flats" forming between frames, particularly at the nose and the float step. If internal bilge pipes are incorporated, the small bilge pump is fitted and any accumulation of water removed. If an excessive amount of water is found the cause should be investigated, as joints at the float capping, plate laps or seams may have opened up. The hand hole covers should be fitted with good jointing washers and screwed tightly down.

Float Supports

The float support struts should be checked for bowing, and all attachment points, at both float and main plane spars, should be looked to for security. Any play at these points will develop rapidly once it has started. Should the top joints of the support be concealed by the main plane covering, any wear at the fittings can be detected by lifting on both the toe and the heel of the float. The points where the floats are most

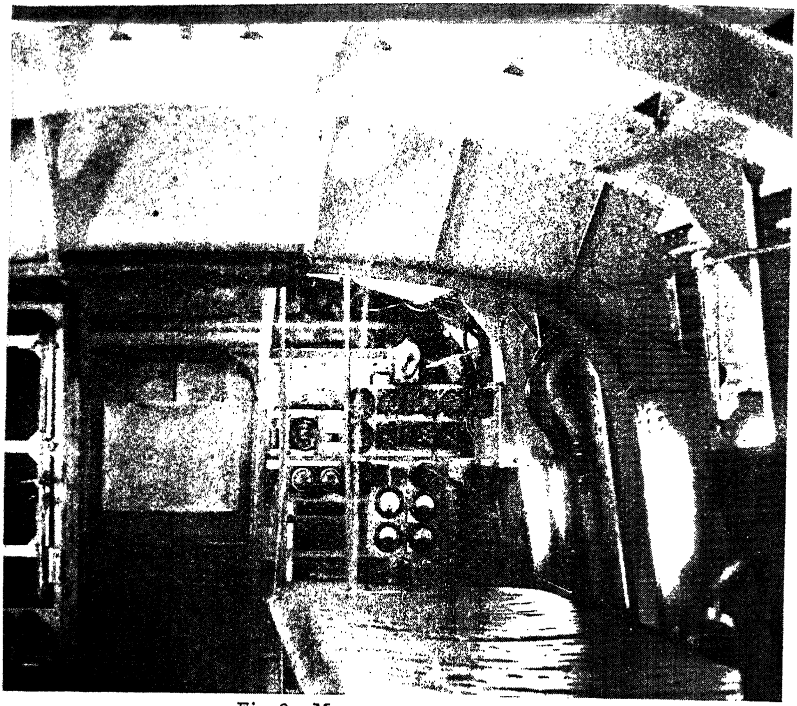


Fig. 8.—MAIN PLANE STRUCTURE.

Showing the rear spar frame. The attachment bolts securing the spar fitting are easily accessible for inspection, as will be seen on the right.

likely to corrode internally are at the keelson and at those points where the support strut attachment fittings are bolted.

Main Plane Structure

If the flying boat is of the monoplane type the inspection of the main plane structure will be simplified. The hull well or that portion of the decking where the main plane is attached is usually provided with inspection doors, and the centre section spars and ribs should be examined. If the main plane is of wooden construction it is important that the ply covering should be in good condition, and that all laps and joints in the ply panels are fabric-stripped to prevent the ingress of water. All drain holes at the trailing edge of the wing, usually of the hooded type, should be kept clear. These may sometimes become choked by flakes of glue
king away from joints where an excess has been applied in
ure

Effects of Moisture

Buckling may be in evidence to a small degree when a boat is moored out in wet weather, but providing this is slight and the top lamination or layer is not cracking, it need not be renewed, as this usually dries out with an improvement in weather conditions.

In the case of metal wings built up of duralumin ribs and duralumin or stainless steel spars, a careful watch should be kept for corrosion. The drainage of the wing must be kept fully efficient and frequent inspections made at those points where moisture is liable to enter through the covering, such as at the wing root fairings, float strut attachment fittings, etc.

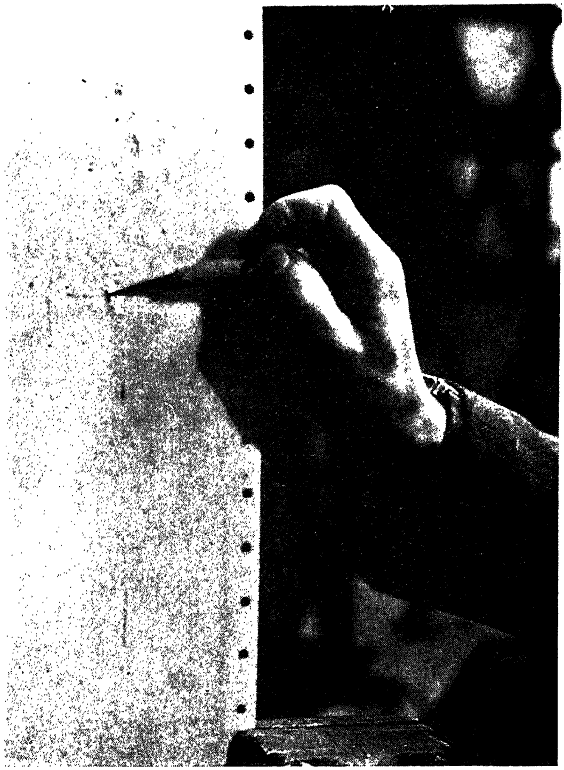


Fig. 9.—INSPECTION FOR SIGNS OF CORROSION.

Showing a badly corroded duralumin plate removed from a built-up, light alloy spar.

Tear-off Inspection Patches

If no provision is made for this, it is advisable to fit tear-off inspection patches, the hole being reinforced by a celluloid ring. All ribs should be checked for being sound. Rib top booms are liable to become damaged around walkways when the latter are provided around engine nacelles.

Repairing a Rib Top Boom

Approved repair schemes are issued for dealing with this type of repair, but when these are not available the fabric covering should be opened up and the boom dressed back to its original shape.

An internal reinforcing channel of the same section should then be fitted inside the boom and secured by distance tubes and nuts and bolts.

Riveting up a repair of this kind is not usually practicable. If it is found that a rib boom is liable to damage in one particular region, it

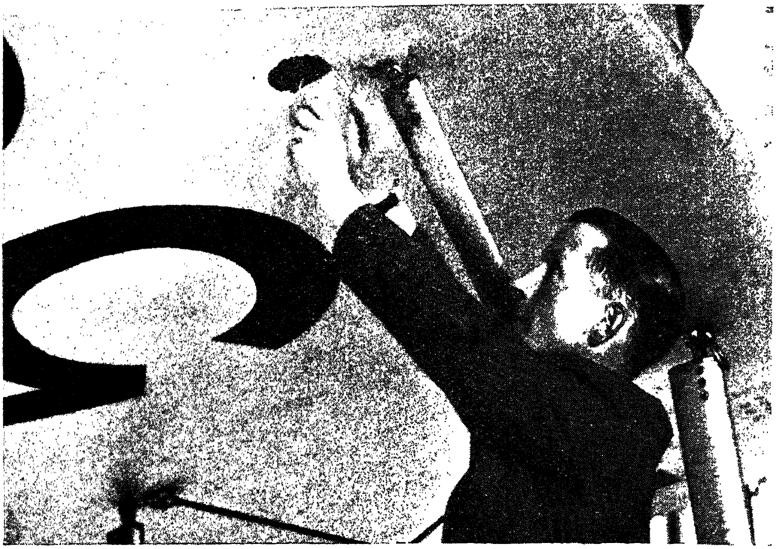


Fig. 10.—TEAR-OFF INSPECTION PATCHES

ion hole obviates sewing up

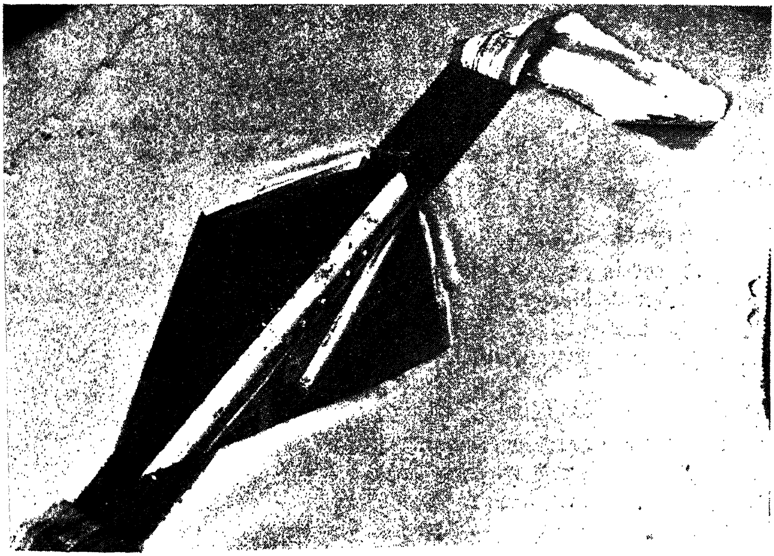


Fig. 11.—ONE METHOD OF REPAIRING A METAL RIB BOOM.

The short vertical member shown is additional support found necessary.

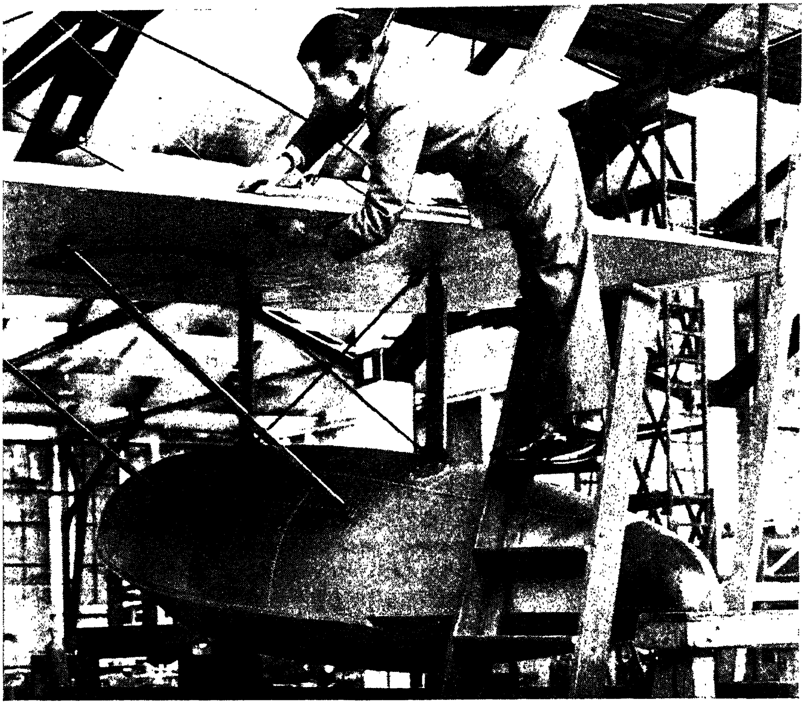


Fig. 12.—SHOWING THE METHOD OF CHECKING RIB BOOMS FOR FAILURE.

may be strengthened by fitting a tubular member of the same material as the rib, vertically between the top and bottom booms. After making the repair, the fabric stringing should be made good. Where possible the fabric is opened up under the rib stripping, this allowing a neater job to be made of the sewing up, being concealed when the strip is doped down again.

Checking Metal Wing Ribs

Discretion should be used when checking metal wing ribs for soundness, as, generally speaking, they are much more flexible than those in a wing of wooden construction. Only a comparatively light pressure of the hand will be necessary in showing up any point of collapse. The fabric covering will not always indicate a rib failure, especially if the stringing is at all slack, the cover tending to remain taut although the top boom has dropped.

In this type of main plane a metal former or capping is fitted to the nose ribs to form a stiff leading edge, and local indentations are sometimes formed. These are not serious providing they do not occur at a nose rib attachment point. When this is so, however, the nose rib attachment to the front spar should be inspected.

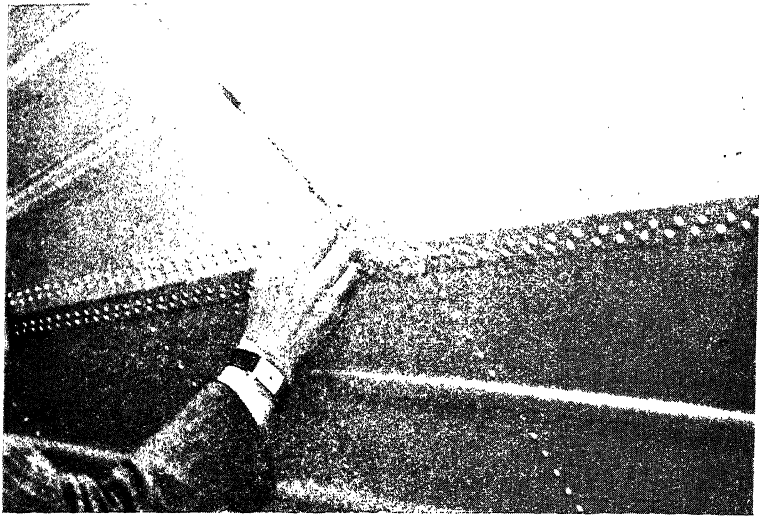


Fig. 13.—CHECKING BRACING WIRES.

All bracing wires are checked for locking and being in safety. The photograph shows a piece of wire being inserted in the inspection hole to ensure that the threaded portion has passed this point in the fork end.

Fig. 14.—EXAMINATION OF FABRIC COVERING.

Making sure that the fabric covering is in a good condition and that all fabric stripping at ribs is doped securely down.

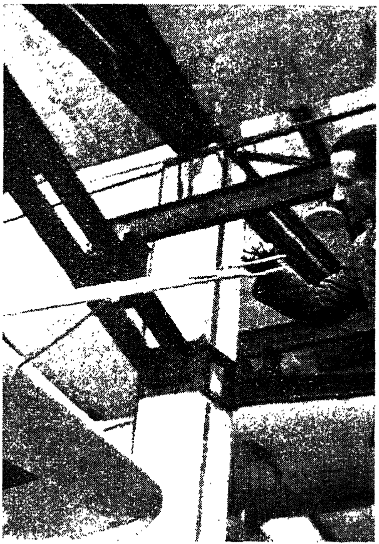


Fig. 15.—THE AIRSPEED HEAD BEING INSPECTED.

Holes around static tube must be unobstructed.

Interplane Struts and Bracings

If the flying boat is of the biplane or sesquiplane type an inspection must be made of all interplane struts and bracing wires. On the larger types of boats these struts will be encased in streamline fairings, and the latter should have inspection doors at both the top and the bottom to give access to the attachment fittings and pins or bolts. It is also advisable to dope a fabric strip on the joints of these doors and so prevent moisture from entering and setting up corrosion. Unfaired struts are checked for bowing by means of a looking-glass placed edge on to the base of the strut.

Are the Bracing Wires "in Streamline"

Bracing wires should be checked for being in streamline, allowing for the angle of the boat as she rides at her moorings. "Spacers" are normally fitted to the bracing wires where they cross one another, and these should always be examined, as they often crack, or their locking devices may fail. If they become detached in flight the bracing wires will chafe one another, and in due course will cut a groove and so cause a failure of the wire due to the concentration of stress at this point.

And Taut

If any adjustments have been made to the rigging of the main planes the wires should be checked for being in safety and all lock-nuts should be tight. The tension of all wires should be tested, remembering that the load placed on them should not be excessive. The bracing can best be checked for tension in flight, when any slackness will be shown up by the wire vibrating. If it is found that a bracing wire has slackened off for no apparent reason, it should be closely examined where the threaded portion enters the fork end or trunnion and the wiring plate or attachment to the spar. The fabric covering of the main planes is checked over for cuts and damage of any kind and also for being taut, and all fabric stripping over rib booms and at leading and trailing edges for being securely doped down.

The Fabric Covering

If the fabric covering becomes at all slack, especially in the region of the airscrew slip stream, the dope should first be removed by means of dope solvent and then given two coats of DTD.26 (cellulose acetate dope), conforming to the scheme on that particular boat. An excess of dope should not be applied as this will quickly flake or crack, especially on a metal wing where the flexure is considerable.

The Ailerons

Whilst checking over the main planes the ailerons should be inspected.

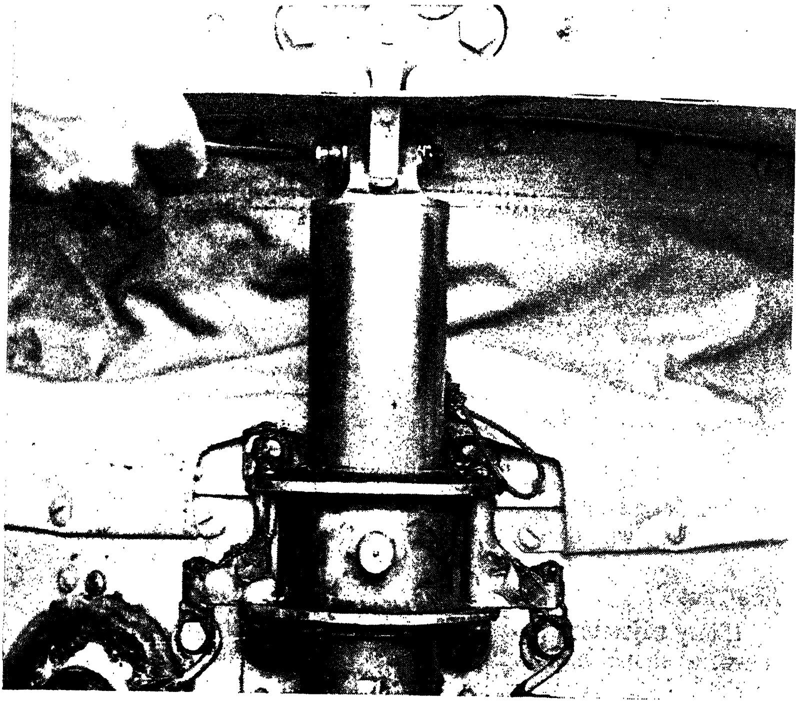


Fig. 16.—ATTACHMENT OF TAIL PLANE.

Always inspect the top bolt at the tail plane slider tube, and keep well lubricated.

Twisting or distortion may be found at the trailing edges, and is found by sighting from the outer end. Certain types of ailerons are balanced by means of an arm carrying the necessary balance weight, forward of the hinge line. This type should have the attachment of the arm to the aileron spar checked for security. The clearance or gap between the main plane and the ailerons at all points should be checked at both full upward and full downward travel. Incorrect adjustment of the aileron control cables may cause a foul at these points.

Aileron Hinges and Pins

Aileron hinges and pins are checked for wear, the outer hinge being the one which will usually first show signs of slackness. This can be detected by holding the end of the aileron and lightly shaking it up and down. This method, however, cannot always be used, especially when dealing with large flying boats of the biplane type, with ailerons on the top planes only. The aileron levers attached to the aileron spars may also be inspected at the same time. These are frequently built up of light alloy and should be watched for corrosion and cracking.

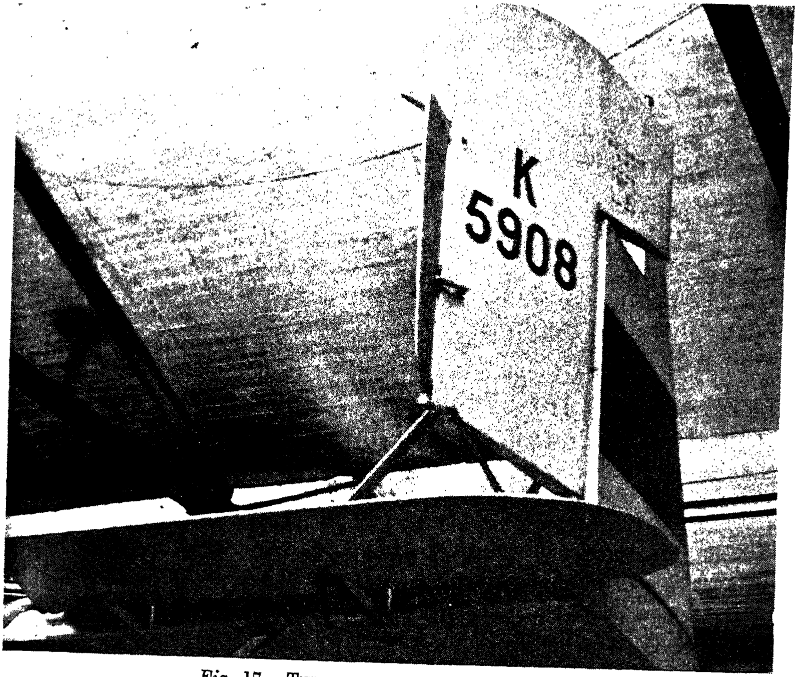


Fig. 17.—The main and servo rudders.

shows the reverse direction of travel of the servo in relation to the main

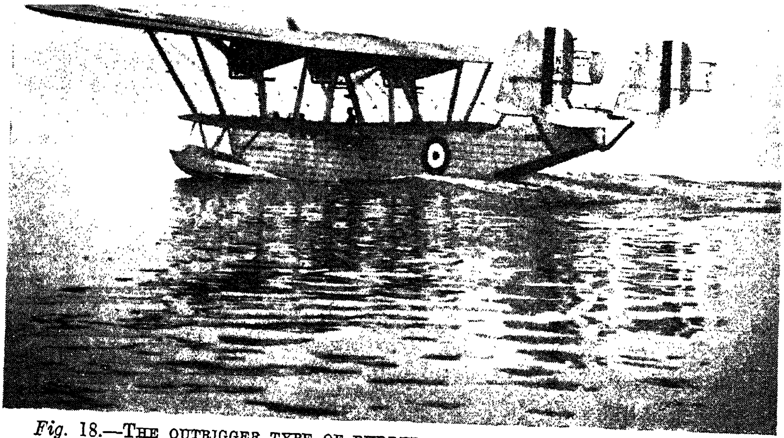


Fig. 18.—The outrigger type of rudder servo can be seen in this view.

The Airspeed Head

Before leaving the main planes, the airspeed head and its mounting should be checked for security. The pressure or bottom tube should be clear and the small holes drilled around the static or top tube should not be choked up by dirt, paint or dope. These points should be checked to ensure effective functioning of the airspeed indicator.

The Tail Unit Inspection

Passing to the tail unit, the tail plane should first be inspected. On the larger type of boats it is possible to walk out along the tail plane spars to the fixed fins and rudders, but care should be taken not to place too great a weight on the rib booms. The walkway is usually marked along the rear spar.

Attachment of Tail Plane

Attachment of the tail plane to both the hull stern and the tail adjusting gear slider tube should be closely inspected. The normal tail plane is pivoted on its front attachment fittings, and the bolts in these fittings must be free to allow of the necessary movement. The rear attachment of the tail plane to the top of the slider tube is often made by means of a bolt passing through a sliding block housed in the top of the slider tube. This block should be free in its recess and so allow of free movement throughout the tail actuating gear range. Tail plane support struts are checked for attachment, bowing and corrosion, and the attachment bolts for slackness in the fork ends. This is more liable to develop in some types than in others.

Elevators

The elevators are examined for damage to the fabric covering and also to the nose ribs. Elevators of the balanced type are more liable to this, being caused when landing in heavy seas, and is due to water passing between the leading edge of the elevators and the trailing edge of the tail plane, when the control column is held back. The elevator hinges and pins are checked for wear, and here again it is usually the outer hinges which show first signs of this.

The Main and Servo Rudders

The main and servo rudders should also have their hinges and pins checked for wear. The attachment of the servo rudder varies with the different types of boats, in some cases being let into the trailing edge of the main rudder and in others carried on outriggers clear of the main rudder. The former type should be inspected for attachment of the servo to the outriggers, and the latter to the main rudder. Drain holes in the fabric covering on all the tail components should be clear, and so prevent any accumulation of water.

Trailing Edge Tubes

Trailing edge tubes usually show first signs of corrosion. An assistant should operate all tail control surfaces to their extremes of movement, while the inspector ensures that no fouling takes place at any point. The rudders are held hard over, first to port and then to starboard, whilst the elevators are tried.

On certain types of flying boats it is possible for one to foul the other when incorrect adjustments have been made to either the control cables or the check wires.

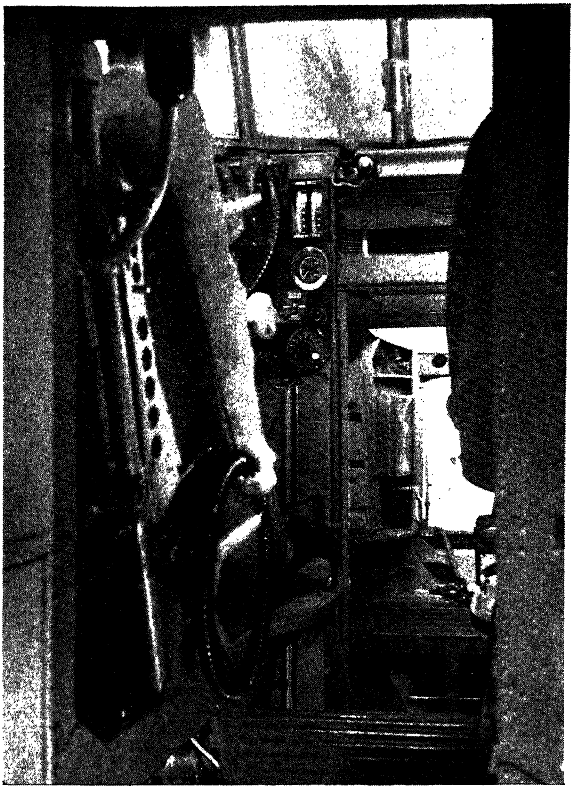


Fig. 19.—TAIL ADJUSTING GEAR.

Checking the tail adjusting gear over complete range, watching the indicator register.

Tail Adjusting Gear

The tail adjusting gear is tried to both extremes for freedom of operation, and when of the spring relieved type the springs and their attachments at the base of the slider tube should be inspected. If no gaiters are fitted to these springs, they should be well protected by grease or sozzle, owing to their exposed position. If any adjustments of an extensive nature have been made to the flying controls, the travels should be re-checked to ensure they are within the specified limits laid down for that particular type.

The Flying Controls

The flying control system should next be checked. All controls should first be checked for operation by trying them from both the first and the second pilots' seats and noting the direction of travel. Ailerons are usually wheel operated, and in this case the port aileron should rise and the starboard drop, as the rim of the wheel is pulled down on the

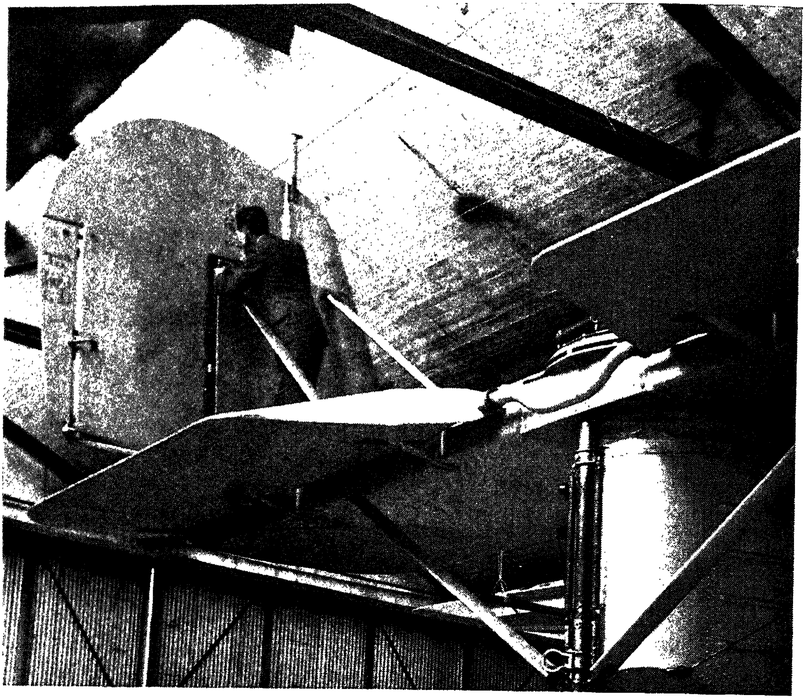


Fig. 20.—THE FLYING CONTROLS.

Examining closely all anchorage struts and bolts at the tail unit for signs of movement.

port side; and the reverse, of course, when the wheel is turned in the opposite direction. The movement should be free and the control should butt hard up on its stops. These may be in the control column gear-box or they may be in the form of stop pins against which a lever in the system will butt up.

Tail Plane Actuating Gear

The tail plane actuating gear is checked for direction of travel and the indicator for functioning. If the flying boat is of the larger type and the tail unit is not visible from the control cabin, an assistant should operate the handwheel, while the inspector watches the tail plane from the deck. On pushing the top rim of the wheel forward the tail plane incidence should increase, in other words, the rear spar should fall.

Elevators and Rudders—Actuating Controls

Elevators are checked for direction of travel, pushing the control column forwards, depressing the elevators and *vice versâ.*

The main and servo rudders are then checked, pressure on the port side of the rudder bar or pedal swinging the main rudders to port. When checking the servo rudders, however, it should be remembered that they move in the reverse direction to the main rudders, that is, pressure on the port rudder pedal swings the servo to starboard and *vice*

Means are usually provided for independent operation of the servo rudders, and where this is so the main rudders must be checked with "servo in" and "servo out." The operating bowden control cable and catch below the pilot's platform should be inspected.

Fig. 21.—THE AUTOMATIC CONTROL.

If an automatic control is fitted, the pins must fully engage. One pin is below the point indicated.

Automatic Control

If an automatic control ("George") is fitted all controls should be checked for operation with both "pins in" and "pins out." The automatic control can then be checked for functioning. The master control cock is turned on to spin the gyros, allowing them to build up speed for a couple of minutes. The controls are then centralised and the pins engaged. The pitch control lever should then be moved slightly to either side of the zero mark, and it should be noted that the movement of the control column follows the lever, that is, moving the lever forward should cause the control column to do the same. The azimuth control and the course changing cock should also be checked. The auto control pipe lines and flexible hoses are checked to ensure that they do not foul when the controls are moved over their full range. (This, of course, will

Fig. 22.—INSPECTION OF CONTROL CABLES (1).

Stranded cables are found at such points as illustrated above, where passing through fairleads, etc.

be done after the auto control master cock has been turned off and pins withdrawn.) Lubrication of the unit is carried out as laid down by the makers.

Rudder Bias

If rudder bias is fitted the operating wheel is tried over its full range, and the bias springs checked for attachment below the pilots' platform. Each separate control run will be examined throughout its length, from the control cabin to the control surface, an assistant moving the control slowly whilst this is being done.

How to Inspect the Control Cables

The cable employed is that known as "extra flexible 7 stranded wire," and is used in conjunction with push-pull rods and swaged rods. When checking through the system, the hand is drawn lightly over the cable to ensure that no strands are broken. This is most likely to occur at points where the cable passes through a fairlead or where it changes direction by passing over a double flanged pulley. If the controls are

Fig. 23 (*right*).—INSPECTION OF CONTROL CABLES (2).

When inspecting flying control cables, ensure that pulley guards are in position and cables run square into pulley grooves.

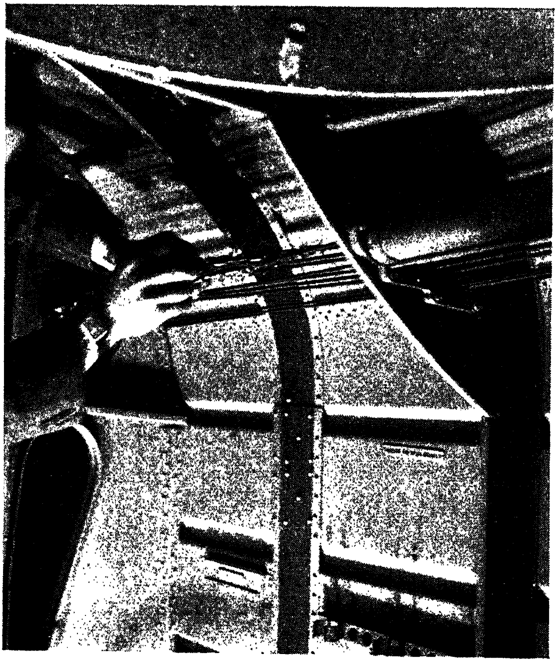


Fig. 24 (*left*).—INSPECTION OF TURNBUCKLES.

Making sure that the turnbuckles are in safety and correctly locked.

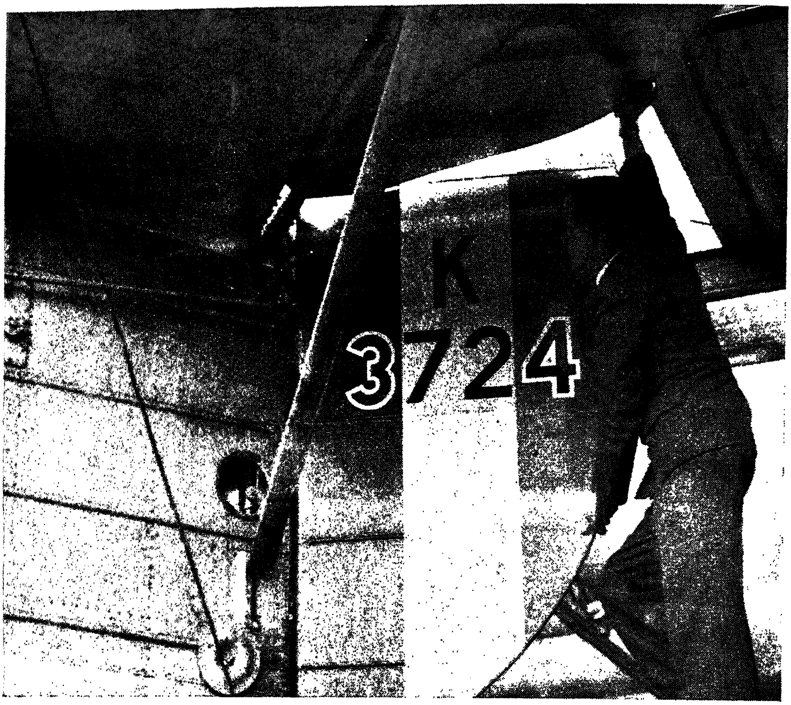


Fig. 25.—FINAL EXAMINATION OF CONTROL CABLES.

After any adjustment to control cables the surfaces are checked for fouls in extreme positions as shown.

moved whilst the inspection is in progress, it ensures that the portion of cable laying in the groove is not missed. Any corrosion found should be removed by means of a stiff brush, not emery cloth, and then protected. If the corrosion has penetrated to the core the cable must be replaced.

Chains and Sprockets

All chains and sprockets in the system are inspected for condition and tension, noting that the detachable links in the former are securely locked.

Pulley Guards and Turnbuckles

Guards are fitted to all pulleys to ensure that the cable cannot leave the groove, and these should be in position and secure. It should be noted that the cable passes squarely into the pulley groove and does not bear on the flanges, as otherwise wear will rapidly occur, with consequent fraying. Should one strand in a cable be found broken, the cable must be replaced at the earliest possible opportunity, although it would not render the flying boat unserviceable. It should, however, be constantly observed until a replacement can be made. All turnbuckles, whether of the tension rod or barrel type, are inspected for being in safety and for locking.

The former type are in safety when the threaded portion passes the small inspection holes provided, and the latter when no thread is shown outside the barrel.

The method of locking should be in the approved manner and in such a way as to resist any tendency for the turnbuckle to slacken off. Inspection tabs are secured at the cable splices to prevent them working along the cable and becoming wedged in fairleads or pulley grooves. All splices that are formed around " dead eyes " should grip the latter firmly and not allow independent movement between the two.

" Check Cables "

It is important that check cables, where fitted, should be examined for condition, as a failure may entail fouling of the control surfaces. If excessive slackness develops in the system for no apparent reason, the cause should be investigated before tensioning. Cable splices may pull, although this does not often happen. Some part of the boat structure carrying a group of control pulleys may partially collapse under heavy loads, and cause this slackness.

If a Cable is Renewed

Fairleads may wear quickly owing to soft fibre being employed and the cable having a fairly large change of direction of run. Should it become necessary to renew a cable or chain they must be proof-loaded before fitting to the boat by applying 50 per cent. of the maximum strength, *i.e.*, a 20 cwt. cable will be proof-loaded to 10 cwt.

Jack, Control Column and Rudder Bar

The tail actuating gear jack, drum and slider tube in the stern are normally accessible for inspection purposes and should be kept well lubricated. Before leaving the controls, it is as well to ensure that the control column and rudder bar locking devices function, as considerable damage can be incurred by leaving a flying boat moored in rough weather and its control surfaces being jerked about in the wind.

Safety Belt

The pilots' safety belts and their attachments should be checked for security of attachment and the quick release fastener checked for operation by fitting the belt in position and exerting a load on the belt by pressing the body forwards.

Seats

If the pilots' seats are adjustable, as is usually the case, they are tried in all positions, making sure that the locking in any one position is positive. All seats and tables in the main cabin should be inspected for being securely anchored to the floor.

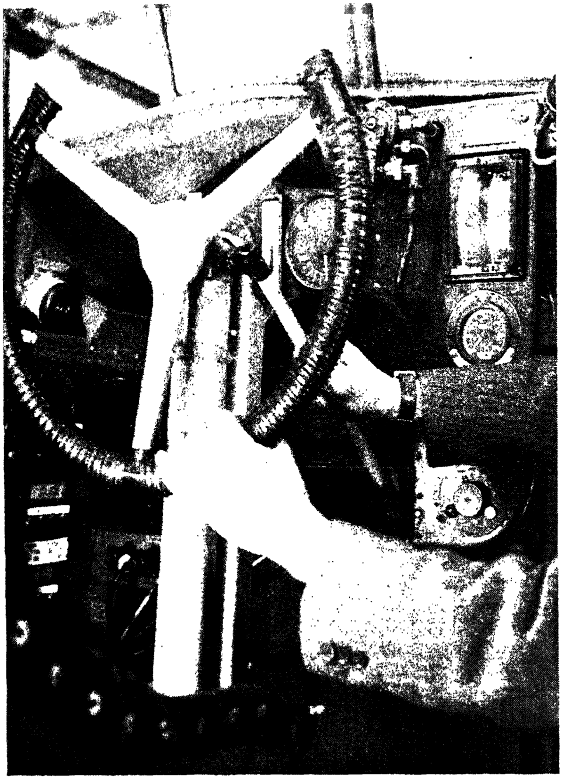


Fig. 26.—CONTROL COLUMNS.

Showing the control column locking device being checked for functioning.

Instruments

The various instruments in the control cabins or at the engineers panel will include the following :—

Compass, turn indicator, clock, airspeed indicator, altimeter, rev. indicators, pressure and temperature gauges, pyrometer, boost gauges.

All these should be visually inspected for signs of deterioration. The functioning of several of them will be checked when the engines are tested.

Compass

The compass fluid should be clear with no signs of bubbles, and the movable verge rings and its clamp should be free to adjust. The compass correction card should be in its holder and visible to the pilot. If the functioning of the airspeed indicator is in doubt, it must be checked by means of a manometer. A rough check on the pipe lines for being tight can be made by blowing very lightly down the pressure tube at the airspeed head and holding the pressure while the instrument is watched for signs of the pointer falling back. When using this method, however, it is extremely important that the pressure should be very light, otherwise the fabric diaphragm or metal diaphragm box inside the instrument may be irreparably damaged.

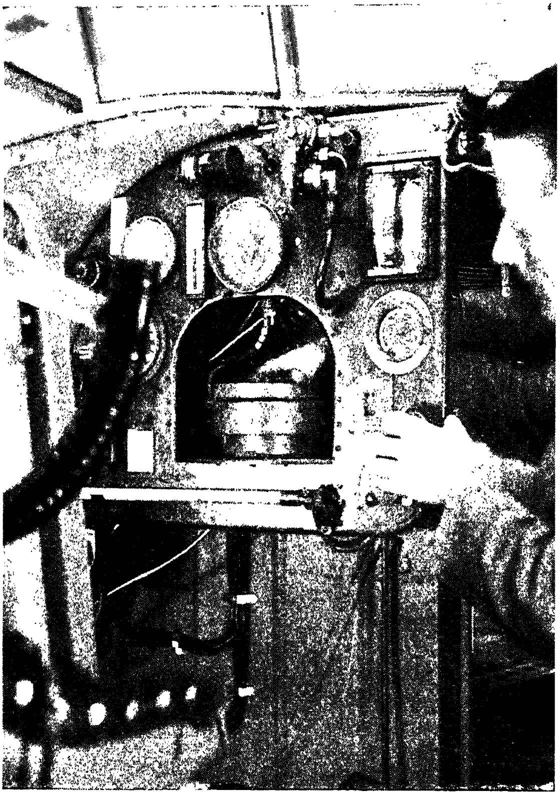


Fig. 27.—EXAMINATION OF COMPASS.

Showing the compass verge ring being checked for freedom of movement.

Altimeter

The altimeter is provided with an adjustable face operated by a knurled nut, and this is tried for movement, as the teeth of the very small pinion engaging the toothed edge of the adjustable face often break away. The revolution indicators may be either of the mechanical or the electrical type. If the latter is fitted, the two pin sockets at the rear of the instrument must be right home on their pins and the spring clips in position.

Instrument Generator

The small electrical generator employed with this type of instrument is invariably mounted close to the engine and should be periodically inspected by unscrewing the end moulding and seeing that the commutator is clean.

Cleaning Generator

The brushes, of which there are two, can be easily removed, but great care should be exercised in the cleaning operations, as both brushes and commutator are very fragile. A small pencil brush is very useful for cleaning the latter. If no reading is obtained when the engine is running it may be due to the fact that the polarity of the leads from generator to indicator has been reversed. They should be changed over at the socket and tried again.

Generator Drive

The drive is given to the generator from the engine by means of a

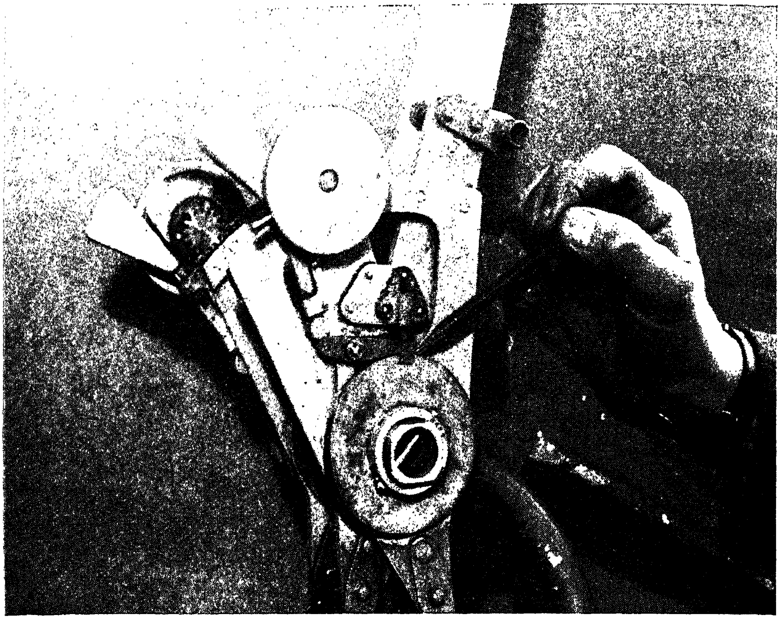


Fig. 28.—THE MIXTURE CONTROL GATE SHOULD BE POSITIVE IN ACTION.

The throttle levers are shown fully open, and the rear mixture control lever is shown in the over-ride maximum boost position.

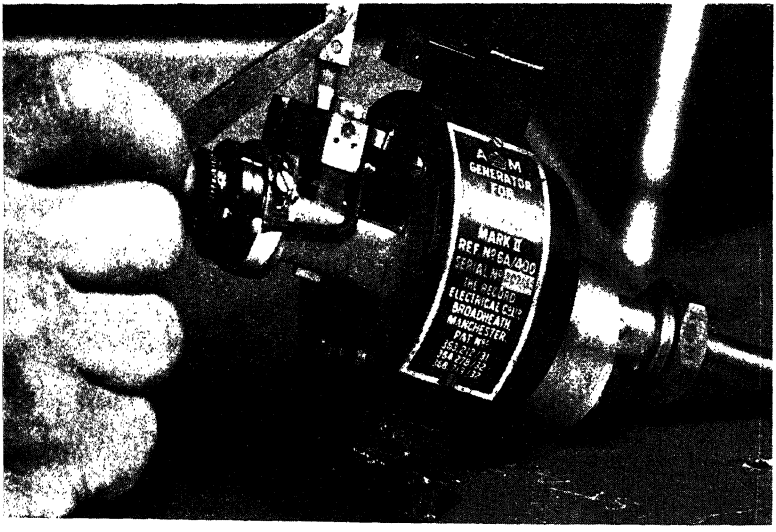


Fig. 29.—INSPECTING THE SMALL ELECTRICAL GENERATOR.

n indicator generator brush
utator. They should be han

short flexible drive shaft enclosed in a flexible casing. The generator end of this shaft should be higher than the engine end, otherwise trouble may be caused by oil or grease finding its way into the generator. A point that should be checked at the flex drive shaft, if no reading is obtained, is to ensure that the end washers are in position, one at either end.

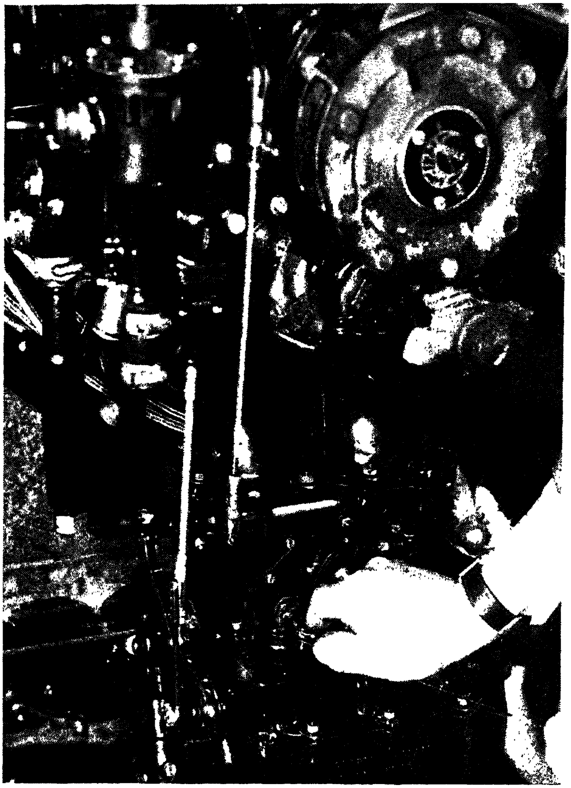


Fig. 30.—OPERATING THE CARBURETTER SLOW CUT-OUT PLUGS TO ENSURE FREEDOM OF MOVEMENT.

Boost Gauge

A drain cock is usually provided in the boost gauge lines to allow of any condensation to be periodically drained off. It will be understood that this is essential, the pipe lines being in communication with the engine gas cases.

Instrument Mountings

Lord type rubber mountings are extensively used in the mounting of both instruments and panels and these should be in good condition, not allowing "bottoming" to take place under normal vibration. All pipe lines and leads behind the instrument panels should be clipped up as continued vibration will cause the former to harden and eventually fracture.

Control and Instrument Services

The number of services from the hull to the engine will vary according to the class of boat being dealt with. On the larger types the following will be found in use :—

Engine throttle and mixture controls, L.T. and H.T. ignition wiring,

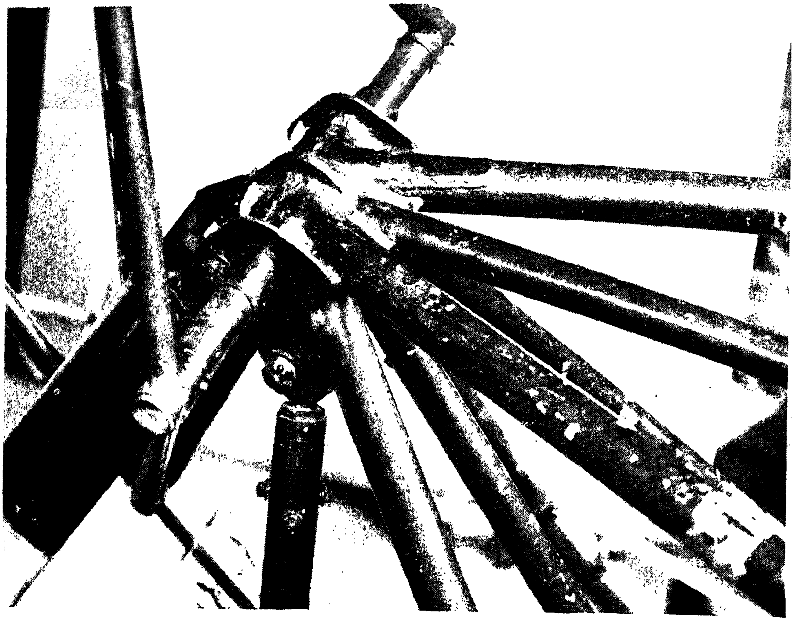


Fig. 31.—ENGINE MOUNTING.

All welded joints in engine mountings and the ends of tubular members should be closely examined for swaging.

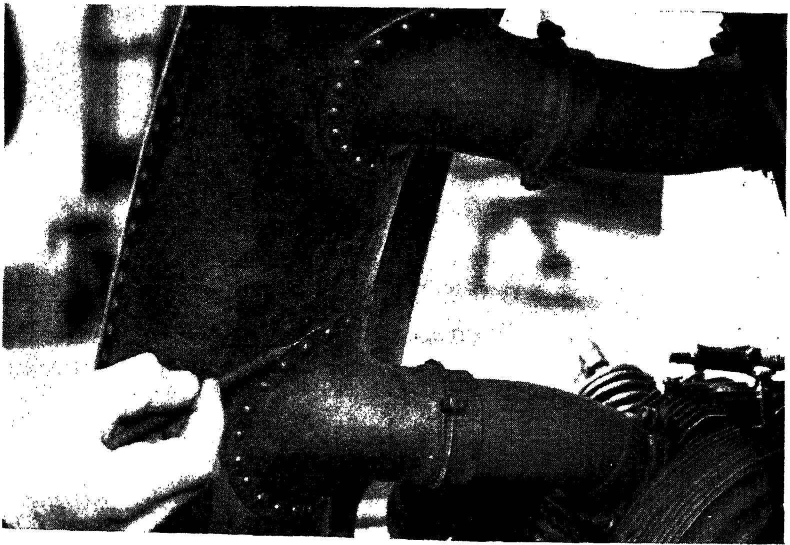


Fig. 32.—CHECKING THE EXHAUST SYSTEM.

Exhaust rings may develop leaks after considerable service and expansion joints may leak.

air intake shutters, carburetter cut-outs and oil short circulating device.

These should all be inspected. The throttle and mixture controls should be checked for excessive back-lash due to wear at ball and pin joints. This is important where supercharged engines are installed. If the mixture control is gated for maximum boost and over-riding of the datum boost, the gate at the control quadrant in the pilot's cabin should be checked for being positive in action.

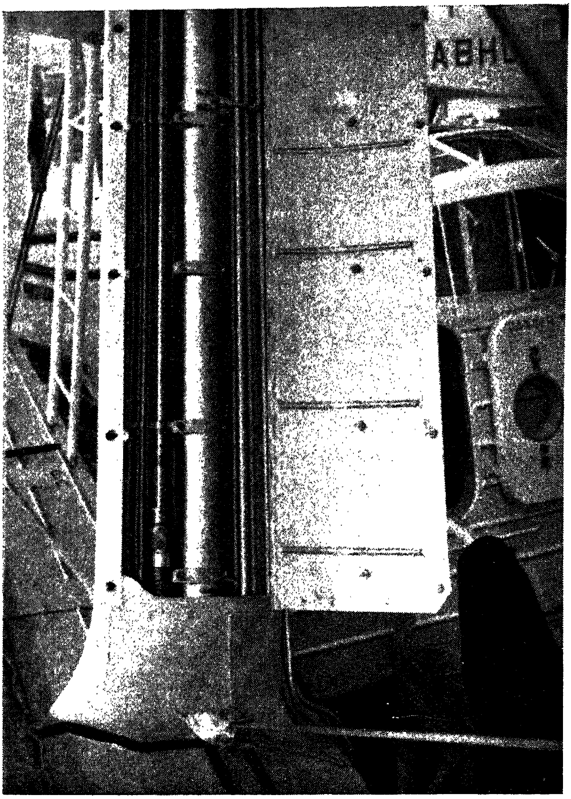


Fig. 33.—SHOWING THE HINGED INSPECTION PANEL BY WHICH THE SERVICES TO ONE OF THE ENGINES CAN BE INSPECTED.

Carburetter

Carburetter cut-outs will need checking to ensure that the movement is free and that there is no danger of the control cables holding the plugs out when the lever is released. The ignition switches should be operated, ensuring that the tumbler mechanism is positive.

Fuel and Oil Tanks

Fuel and oil tanks, when not covered in, are inspected for security and freedom from leaks. If the fuel employed is of the leaded type, *i.e.*, D.T.D.230, leaks will be easily detected owing to the colour of the fuel. All flexible and copper or stainless steel pipe lines should be free from leaks and the tank vents must be clear. In the case of the oil system, rubber hose joints should show no signs of deterioration. A point not previously mentioned is, that if the flying boat is carrying W/T., the complete flying boat must be bonded. This fact should be borne in mind when carrying out the complete inspection and any point where the bonding is incomplete should be made good. The term " bonding " implies that all metal components in the boat are brought into metallic contact with one another, by means of flexible braided copper wire or strip. Magnetos and ignition leads must also be screened.

Engine Nacelles

Passing to the engine nacelles, all detachable cowling panels are first removed and the engine mountings closely examined at all joints. If the engines are carried in nacelles in the top plane the points of attachment to the front spar should be examined for any signs of movement.

Engine Mountings

In the case of welded engine mountings, cracks may sometimes be found in the region of the welding or tubular members may stretch under heavy loads, such as those incurred when making a bad landing in a rough sea. This will show up in the form of a " neck " or " waist " in the tube, close to one end. If the mountings are wire braced, the wires should be checked for tension and the wiring lugs or fork ends for signs of pulling or elongated holes.

Shock Absorber Units

Lord type engine mounting shock absorber units are now being used, and due allowance should be made for movement between the engine, pipe lines, etc., and the cowling when the engine is running slowly in the cold condition. Movement between two joints can often be detected by means of a dirty coloured paste which will work away from the affected joint.

Cowling Formers

Cowling formers, if of the welded type, are examined for cracks, as also are the cowling panels. A small crack can often be checked by drilling a small hole at the inner end of same. Various types of cowling fasteners are employed, but whatever the type the cowling must be firmly and securely held in position.

Exhaust System

The exhaust system is next checked over. If stub pipes are fitted this is a simple matter. They must be firmly held at the exhaust ports, and should allow the exhaust gas to blow clear of the structure at all points. The joint at the exhaust port must be gas tight, as there is a tendency for leaking gas to dry up the valve stems and guides, with consequent seizing of the valve. Should an exhaust collector ring be fitted, a close watch should be kept for cracks at the junction of the short pipes with the main ring. Expansion joints should be free, and any support stays embodied in the design securely attached to the engine. The tail pipe and its support can be inspected at the same time. The former is often carried by a spring loaded strap and fitted with a check cable as a safety precaution. This cable should be in position and serviceable.

Townend Rings

Townend rings and their supports and fasteners also need attention, as the former are often of a light gauge material and crack after continued service.

Airscrews and Spinners

The airscrews and spinners are next inspected, and if of the wooden type the blade roots should be examined for opening up of the laminations. Spinners, when fitted, should be secure and not chafing on the airscrew boss. Loose hub bolts can be detected by looking at the joint where the rear hub-plate sits up against the rear face of the airscrew boss.

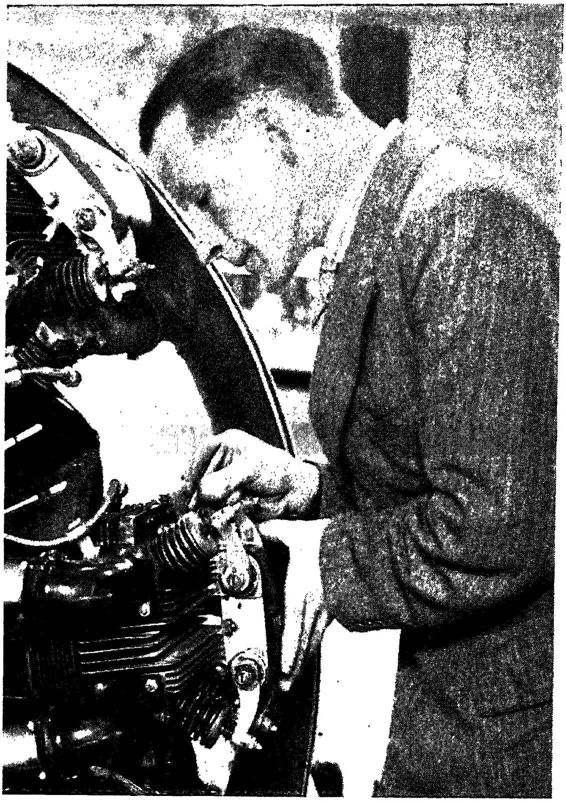


Fig. 34.—VALVE SPRINGS BEING INSPECTED FOR BREAKAGES.

The crankshaft should be turned to bring both valves closed, as the inner springs cannot be seen when the valves are open and the spring compressed.

The leading edge sheathing on the blades may be working loose, in which case it should receive immediate attention.

Dealing with Corrosion

If the airscrew is of light alloy, corrosion may set up at the leading edges of the blades and should be checked in its early stages by cleaning down with a dead smooth file, afterwards removing all marks by polishing.

The V.P. Airscrews

When facilities are available the blades should be re-anodised. In the case of variable pitch airscrews, the maintenance schedule as laid

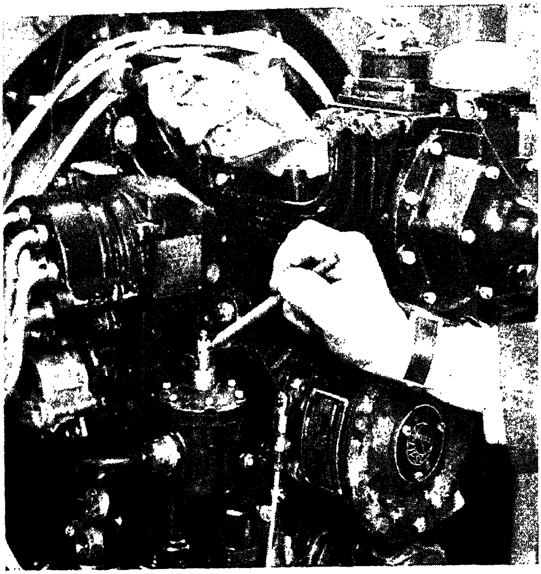


Fig. 35.—THE AUTOMATIC BOOST CONTROL.

Checking the locking of the automatic boost control, as any alteration of the setting affects power output.

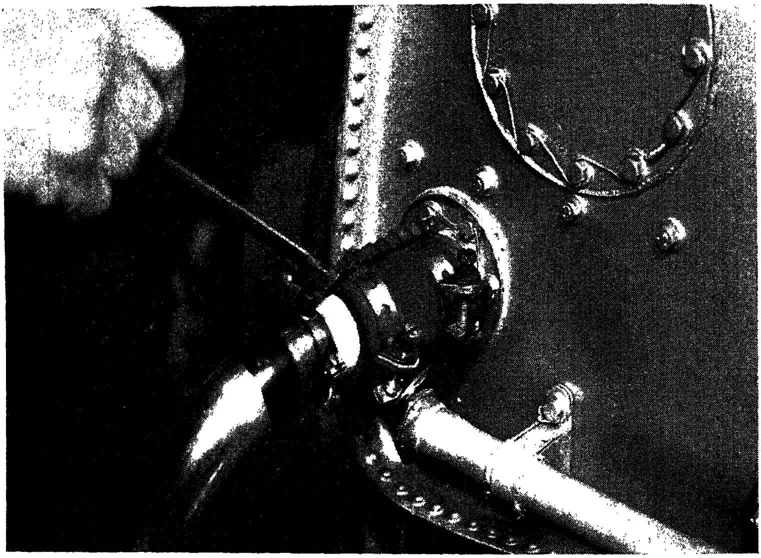


Fig. 36.—ONE METHOD OF BONDING A RUBBER HOSE JOINT. This is necessary when the flying boat is carrying W/T.

down by the makers is carried out. Its functioning can be checked when the engine is running, by observing the movement of the front cylinder.

ENGINE INSPECTION

A general inspection of the engines should now be carried out. The type of engines will vary, but the supercharged static radial can be taken as an example.

If a periodical inspection on the engines is due, this will be carried out. If not, the inspection should be on the following lines:—

External Inspection

All external nuts should be tight, intercylinder baffles secure and undamaged and no signs of movement at crankcase joints, cylinder bases and cylinder head joints. The engine attachment bolts should be inspected and sparking plugs and leads checked for being secure.

Thermo Couple Attachments

If thermo couples are fitted to the engines, the attachments to cylinder heads and crankcase should be examined.

Valve Stems

If hardened steel thimbles are fitted to the tops of the valve stems, as is general, these should be examined for being in position. It is not unusual for these to fracture and fall away.

Valve Springs

Valve springs should be checked for breakages. The crankshaft should be turned to bring both valves closed, as the inner springs cannot be seen when the valves are open and the springs compressed.

Casing and Joints

The front portion of the engine should be kept free from salt water spray, otherwise the light alloy reduction gear-case, cam gear-case, etc., will rapidly corrode. Induction pipe joints can be inspected for soundness and all accessories at the rear of the engine, such as oil and fuel pumps, fuel and oil filters, compressors, etc., checked over.

Ignition

The low tension ignition switch wiring to the magnetos should be secure, and the cable sheathing bonded to the engine mounting.

Carburetter Link Work

All link work at the carburetters should be free and all cotter pins secured by split pins. The lock-nut at the automatic boost control adjustment should be examined for locking, and the slow running cut-out plugs tried for freedom.

Now Test Engine

If this inspection proves that everything is in order the engines should be tested. A tail line should be attached to the stern of the flying boat if it is moored at a buoy, and made fast ashore. Main fuel supply and oil cocks are turned on and the engines primed. Starting may be by one of several methods.

If electric starters are fitted the engine is allowed to turn over a couple of revolutions before switching the ignition on and turning the hand starter magneto.

Another method is starting by means of compressed air combined with a gas distributor on the engine. A press cock or valve is placed in the supply line to the distributor, the air picking up petrol vapour from an atomiser on its way to the engine.

Running Up to Speed

When the engines are running they should be allowed to run slowly at about 800–900 r.p.m. to allow the oil pressures to build up. The oil tank short circulating device should be in operation to assist in warming the oil, and oil cooler by-pass valves should be opened. As the thermo gauges begin to show signs of movement the engine speed can be increased to 1,200–1,400 r.p.m.

Check Pyrometer

The pyrometer can be checked for functioning by switching over to the different cylinders, noting that a reading is obtained for each. When the oil temperatures reach 40° C. on the outlet side, the air intakes shutters should be opened. The engines are then opened up to full throttle, one at a time, making the following observations :—

Engine Revolutions, Oil Temperature and Pressure

R.p.m. should be normal and the drop when running on either magneto should be within the specified limits, *i.e.*, 5 per cent. Oil temperatures and pressures should be noted for all engines.

The Fuel System

Fuel pressures should be noted, and if the pressure side of the fuel system is balanced the reading must be taken with each set of pumps isolated. Boost pressures should be noted, with the mixture control in the normal position and in the over-ride.

Acceleration and Slow Running

The engines are then throttled down and each checked in turn for smooth acceleration and for slow running. The r.p.m. obtained may vary slightly according to the density of the atmosphere of the day, and allowance should be made for this.

Now Test Carburetter Cut-out

The engines should be allowed to run for two or three minutes before switching the ignition off, and the carburetter cut-outs can be tried at this stage.

Auxiliary Power Unit

Should an auxiliary power unit be employed on the flying boat it should be checked for starting and running. A visual check should be made of all electric lighting services if the boat is employed on night flying.

Navigation Lights

Navigation lights and all instrument lighting should be checked in turn. Holt flare wiring can be checked by interposing a lamp in the circuit with the flare terminals disconnected. Landing lights are checked for functioning and swivelling, and where a drogue signalling device is fitted it should be checked at all readings.

Wireless Equipment

The W/T. equipment will be checked by the operator, but all aerials and check wires can be examined for security and lead-in insulators for being clean and free from dope and paint.

Marine Equipment

A check is made on all marine equipment such as drogues, boat hook and line, anchor and chain, smoke floats, Very pistol and cartridges, life-belts, fire extinguishers, etc., and providing the flying boat complies with the necessary requirements, such as having a current Certificate of Air-worthiness, etc., it can be passed for flight.

It will be seen from this article that the inspection of the flying boat must be methodical with no detail being overlooked. The scope of this work is covered by the ground engineer holding licences in Categories A and C.

PHILLIPS & POWIS AEROPLANES

THEIR INSPECTION AND MAINTENANCE

By G. A. Mann, *Chief Inspector, Phillips & Powis Aircraft Ltd.*

THERE is considerable variation between every type of aircraft. Each designer has his own ideas, and so his aircraft differ in general appearance from those designed by his rivals. In the same way, types of aircraft designed by the same man will differ quite largely one from another. Therefore it would seem best, firstly to deal with the designer's general characteristics and the detailed differences between the types he has produced, and then with maintenance, repair schemes and rigging.

General Remarks

Aeroplanes constructed by Messrs. Phillips & Powis Aircraft Ltd. are low-winged cantilever monoplanes built of spruce, embodying a stressed skin construction in the majority of components. This type of construction has the following advantages : in the first place all drag stresses are taken up by the skin, which does away with costly and weighty internal drag bracing. The skin thus serves the dual purpose of covering the component and taking a share of the loads. It also makes a more solid and durable surface on which an excellent finish may be obtained. The elimination of drag bracing also simplifies maintenance very considerably. The wings consist of two box spars with a false spar to carry the aileron, spaced by light ribs and covered with 1 mm. three-ply. On all these types the wings are arranged for folding, being hinged on the rear spar with a section of the wing built as a folding-flap. The ailerons have a box spar at the leading edge and are ply covered. The centre section is of the same general design as the wings, but the ribs between the spars are designed to carry the fuel tanks. The centre portion is completely free and the tank is cradled in this space. A tank is fitted on each side of the centre section of any capacity from 11 to 22½ gallons to suit the owner's requirements. The wide-track undercarriage is attached to the centre section at the wing attachment fittings, different types having different methods of assembly.

The fuselage is of semi-monocoque construction, the four longerons and all the struts being of spruce and the skin of three-ply. It is only in the tail unit that stressed skin construction is not usually employed. The tail plane consists of two solid spruce spars with wire drag bracing, the whole being fabric-covered. The elevators and rudder have a spruce and three-ply box-spar to which light ribs are attached, the trailing edge

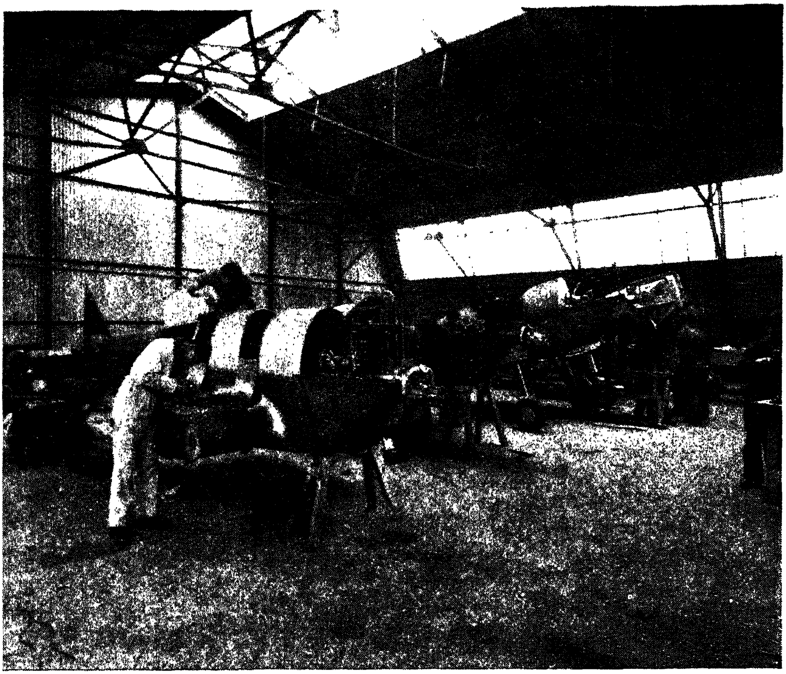


Fig. 1.—THE CIRRUS HAWK.

The wooden engine bearers should be contrasted with the tubular ones fitted to other types.

being dural tube, and the covering fabric. The fin is of similar construction, but the fin post is of solid spruce.

On the later aeroplanes all plywood surfaces are covered with Madapollam, which gives a still better surface for the finish and also protects the structure under tropical conditions.

This brief description gives the general characteristics and it is now necessary to deal with individual types in detail.

CIRRUS HAWK

This is the first production type built by the firm, but although it is the ancestor of all Hawk types, it is still in service at many schools and clubs.

Type and Construction

It is a two-seater with open tandem cockpits, in direct contrast to the latest practice. The engine is a Cirrus III, developing 95 h.p. at 2,100 r.p.m. The engine bearers are of wood with ply sides, the top rail and

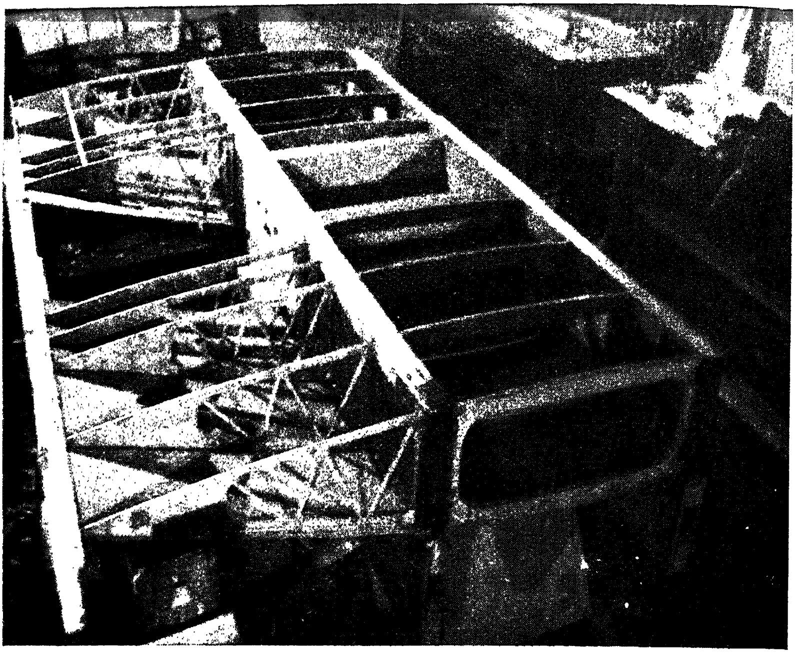


Fig. 2.—THE CIRRUS HAWK.

The centre section about to have its bottom skin fitted, showing the special tank ribs very clearly.

forward sloping member being of spruce and the upward sloping member of ash. The ply covering is glued, screwed and bradded to the fuselage, and flitch plates connect the main members with the fuselage struts and longerons. Torsional bracing is by two tubes running from the rear engine attachment fitting to a bracket in the centre of the bottom fuselage cross strut. The fireproof bulkhead consists of a sheet of 26 gauge charcoal iron backed with three-ply.

The tandem cockpits are fitted with full dual controls, the master set being in the rear with the front ones easily disconnected. The rear cockpit has a complete set of instruments, parking brake lever, engine switches, rudder and elevator bias and throttle control to the engine. A standard set of speaking tubes and two sets of lap straps are provided. The top deck and engine cowling carry through from the rear cockpit to the nose cowl in a straight line, parallel to the top longerons. Two windscreens, consisting of a frame and three pieces of safety glass, are mounted by means of metal threads to the decking, and crash pads are laced to the front of the cockpits. There is a door to each cockpit on the starboard side, a treadway being provided on the centre section.

Engine Cowling

The engine cowling consists of light gauge aluminium panels with louvers arranged to direct the airflow round the engine. The nose portion is mounted on the front of the engine bearers and the remaining panels, side and bottom, are attached by long pins, a common method at the time this aeroplane was designed. The exhaust pipe is on the port side with a tail pipe to carry the exhaust gases clear of the rear cockpit.

Planes

The tail plane, elevator and fin are standard, but the rudder is not balanced statically or aerodynamically.

The wings and ailerons are standard, but the latter are not fitted with mass balances.

Undercarriage

The wide track undercarriage is mounted on a centre section of normal construction. The undercarriage is of the split axle type, spring damped with a single compression leg each side. The top attachment fitting for the compression leg is under the front spar near the wing root fittings, the split axle going up to a point under the same spar at the fuselage side. The radius rod is carried back to a bracket on the front face of the rear spar immediately behind the compression leg. The compression leg consists of two tubes, one sliding within the other, a coil spring taking the landing loads, and a retaining rod taking the rebound loads. The tail skid is damped by a spring in tension. The fulcrum point of the skid is approximately in the centre, and this is attached to the base of the stern post. The spring is fixed to the top of the skid and to a cross tube in the rear bay of the fuselage. A detachable shoe is fitted to the other end of the skid.

Controls

The controls are cable-operated, of simple design and easy to inspect. The control unit in the cockpits is mounted on a tube, carried on bearings on the datum line of the two spars. This tube also supplies the rotating movement for the aileron control. All the actuating levers are carried on the tube behind the rear centre section spar and the movement is carried out to the control surfaces by 15 cwt. cables. The movements are finally transmitted to the aileron by an actuating plate and connecting rod, which will be described under "Rigging." The elevator cables connect to a lever carried on a cross shaft in the rear bay of the fuselage, from the upper part of which a rod connects with the elevator king-post. The rudder actuation is entirely by cable from the rear rudder bar. The elevator bias is by spring loading ; the lever in the rear fuselage bay has a piano wire from the top and bottom connecting to a lever in the cockpit, a spring being incorporated in each of these wires. The rudder bias consists of a spring attached to the port side of the rudder bar, a knurled knob on the rear instrument panel being used to tension it by means of a bowden cable.

HAWK MAJOR

This aeroplane is a modernised version of the Cirrus Hawk.

General Notes on Construction

The engine is a D.H. Gipsy Major rated at 120/130 b.h.p. This is carried on welded square section steel tube bearers, suitably reinforced with flitch plates. The engine is mounted on rubber blocks which fit into special housings in the bearers, being held in by means of steel caps. This type of mounting is used in varying forms on all other Miles types at present in production. Torsional bracing is similar to that already described.

The cockpits have the same general layout, but with the addition of a flap operating lever on the starboard side, this being the first type to incorporate flaps. This lever works in a slotted quadrant which gives a choice of flap positions. The top deck slopes downwards from the front of the front cockpit and the cowling carries this slope on to the nose cowl.

Cowling Layout

The whole cowling layout is simpler than on the earlier type, two variations having been fitted. The earlier version consists of a nose cowl cut short level with the engine rocker-boxes, a top cowl and a tray, which also forms the bottom curve of the nose. Two side panels are mounted to the top cowl by pins and are fastened at the bottom by quick release clips. This is now modified to a type of cowling which gives complete access to the whole engine installation simply by lifting the two side panels. The nose cowl is carried right down at the expense of the tray and the two side panels are made to do the work of the top cowl, being hinged along the centre line. Thus, by undoing the two fasteners on one side, the whole panel may be lifted and held in place by a special support provided on the engine frame. There is a clip on each side of the bulkhead for these supports when not in use. Since this is an inverted engine, the exhaust is carried away under the fuselage, a short extension pipe being fitted.

Planes

The standard tail unit is fitted, but the rudder is statically balanced. The centre section is a little wider than on the Cirrus Hawk.

Undercarriage

The undercarriage consists of a separate unit, completely faired in by an aluminium spat on each side. Each unit consists of two compression legs of the same general design as the Cirrus Hawk, but with the wheel carried on a short axle between them. These are mounted to the centre section spar by welded fittings carried on the spar plate bolts. A drag strut from each leg is attached to a common fitting carried on two of the rear spar-plate bolts. The spat has a detachable front portion for inspection purposes. The skid is the same as that on the Cirrus Hawk.

Oil Supply

There is an oil tank of 3 gallons capacity carried on the port side of the centre section, forming a portion of the leading edge. The oil delivery and return pipes run inside the fuselage to the engine, thus maintaining a clean finish.

Control System

The control system is the same as that of the Cirrus Hawk except for mass balanced ailerons and the addition of flap gear.

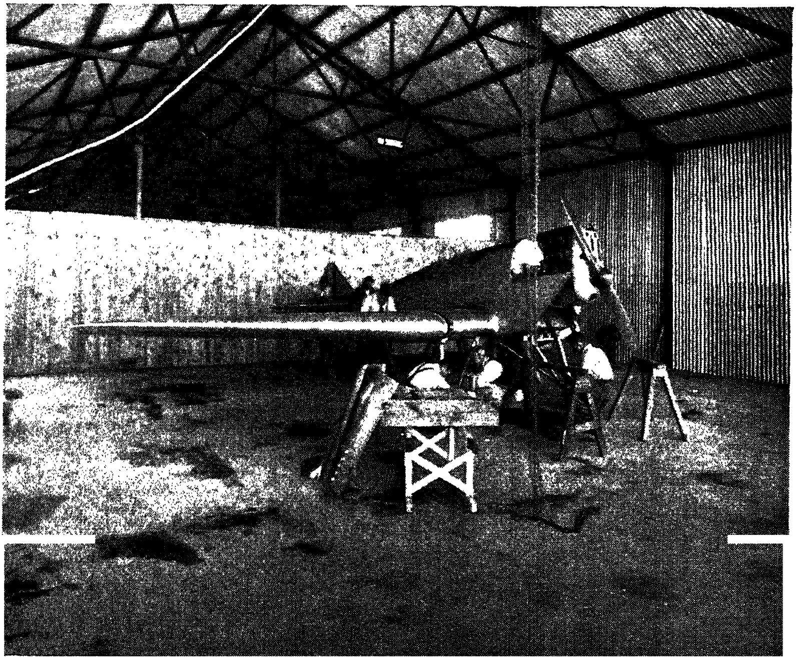


Fig. 3.—THE CIRRUS HAWK.

The trailing-edge flaps are fitted to assist the aeroplane in landing, since the design is so clean that it would otherwise tend to float. There are five separate flaps hinged at their leading edges and of 9-in. chord. These are lowered by means of levers and links mounted to separate torque tubes, which are connected by a rod to the operating lever in the cockpit. The outer flap is on the wing-folding flap and is connected to the centre section flap torque-tube by a dog. The rudder bias spring is on the starboard side as the Major has opposite rotation to the cirrus.

HAWK TRAINER

This is the de luxe and training school version of the Hawk Major.

General Notes on Construction

The engine and installation are the same as for the Major.

The fuselage is 3 in. wider at the cockpits to make extra space for parachutes and Sidcot suits. Two complete sets of instruments are fitted and provision is made for a blind-flying hood. The two parachute seats are of aluminium, the rear one swinging forward when the top attachment bolts are removed so that the controls may be inspected. Two sets of Sutton harness are provided.

Control System

Flying controls are the same except for the sticks, which are slightly longer and have a set in them. The other controls have been re-arranged. The elevator bias is fitted in both cockpits on the starboard side and a larger knurled knob has been fitted to the rudder bias. The flaps are hydraulically operated by pump and ram, the pump unit being on the port side. Mounted on the outside of the fuselage, but inside the centre section, is the ram which operates the torque tubes. The connections between the pump and ram are of copper tubing. The pump has an operating handle on top and a small lever for reversing the direction on the front. A flap-position indicator is fitted on the dashboard.

Rear Tail-Plane Spar

The aerobatic Hawk at an all up weight of 1,750 lbs. has a strengthened rear tail-plane spar in which the packing block extends for 12 in. against the standard 9 in. each side of the centre line. The rudder is aerodynamically balanced by a horn, the area for which is taken off the top of the fin ; the chord is also slightly increased.

FALCON MAJOR

This is the first cabin aeroplane built by this firm.

General Notes on Construction

The engine is a Gipsy Major carried on bearers of similar construction to those of the Hawk Major. The fuselage is considerably wider to allow for side by side seating. Most aeroplanes of this type seat four, two in separate seats in front and two on the full-width back seat.

Control System

The dual rudder controls are of the pedal type, two torque tubes are carried across the width of the fuselage and are connected by toothed quadrants in the centre, the left and right foot pedals being mounted on opposite tubes. The stick is mounted in a central control box so that it can be used from either seat. The stick is jointed half-way up, the lower portion swinging to and fro for elevator control, and the upper portion sideways for aileron control. The latter movement is transmitted by chain and sprocket to the rear of the front spar, whence two tie-rods connect to an actuating lever on the rear face of the rear spar: from this point aileron controls are normal. The elevator controls are actuated by a cable attached to the bottom of the stick. This is carried forward to a chain and sprocket mounted on the front of the box, whence it is carried back through a slot in the stick to form the top elevator cable; the bottom elevator cable is taken straight from the bottom of the stick.

Single throttle and mixture controls are fitted, as push and pull knobs, to the instrument panel. The elevator bias is by spring mounted directly on the control box with a lever to vary the tension.

Brakes

Bendix brakes are fitted with a parking brake handle on the port side. The flaps are the same as for the Hawk Trainer.

Windows, Windscreen and Instrument Panel

The cabin is fitted with a sliding window on each side, and a Lancegay forward sloping windscreen with a moulded Perspex top. The instrument panel is in one piece with the instruments mounted on the port side. Entry to the cabin is by sliding door on the starboard side. The whole cabin is upholstered in leather and sound-proofed by Rumbolds.

The aeroplane is otherwise standard except that stronger springs are fitted to the undercarriage compression legs and two springs to the tail skid.

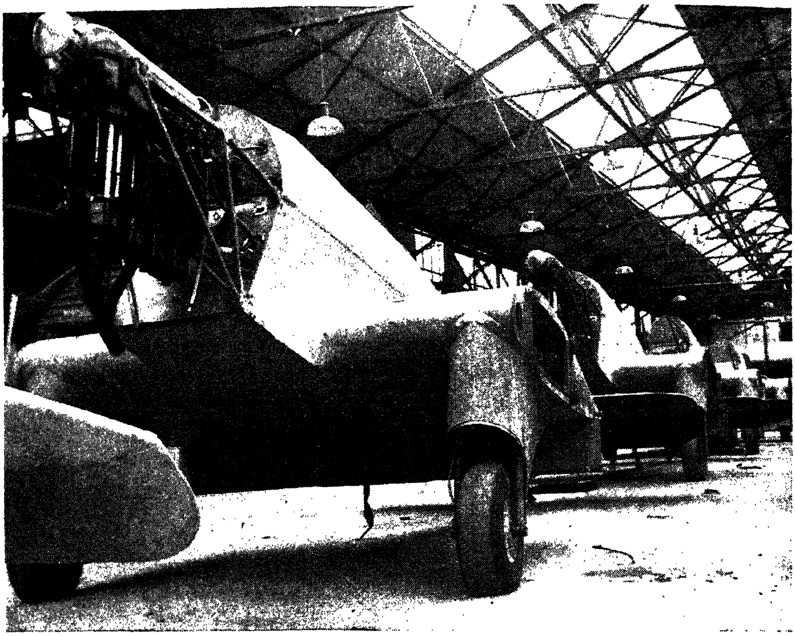
FALCON VI

This is a more powerful version of the Falcon Major, carrying three at a top speed in excess of 170 m.p.h.

General Notes on Construction

The engine is a D.H. Gipsy VI, developing 200 b.h.p.

The cabin seats one pilot in the centre and two passengers on the rear seat, the seats being mounted on the centre section spars as on the Falcon Major.



[*By courtesy of " The Aeroplane.*"

Fig. 4.—THE HAWK MAJOR.

The engine mounting, undercarriage and the detachable portion of the spat can be seen. Note also the tank rib and the wing attachment fittings.

Controls

The rudder bar is mounted on the front end of the control box, which, apart from the elevator bias, is very similar to that already described. Elevator bias is by trimming tab, the lever for which is on the port side of the box. This is connected to the tab, which is on the port side of the elevators, by two Bowden cables. The rudder bias lever is on the starboard side of the box, a spring coupling this directly to the rudder bar. The brake lever is mounted on the port side of the centre section spar. The throttle control is by lever, but the mixture control is the same as for the Falcon Major.

Instrument Panel

The instrument panel is made up in three pieces, with the centre panel designed to take blind-flying instruments if required. The cabin and outside appearance are otherwise the same as for the Falcon Major, except for the longer engine cowl.

Tail Wheel

This type is fitted with a tail wheel which necessitates a cut-away at the bottom of the rudder. The tail wheel unit is mounted at the base of the fin post, and is fully castoring, the landing shocks being taken by rubber in compression. Apart from this the aeroplane is the same as the Falcon Major.

MILES WHITNEY STRAIGHT

This is the latest type of civil aeroplane which this firm now have in full production.

General Notes on Construction

It is a cabin type with dual controls, seating two side by side.

The Gipsy Major engine is mounted on bearers of normal construction, but arranged for easy removal. The attachment fittings to the fuselage are quite separate from the bearers, the side frames of which are fitted by special hollow bolts. It is thus possible to remove a side frame without taking the fitting off the fuselage. In order to shorten the pipe runs, the aluminium oil tank is mounted behind the engine on the fireproof bulkhead. It is of cylindrical construction, and the oil capacity is 2½ gallons. The fireproof bulkhead consists of a sheet of asbestos against the fuselage ply with a sheet of 26 gauge charcoal iron in front.

Cabin Accommodation

The cabin is very roomy, the seat being attached to the rear face of the front spar and extending the full width. Behind this there is a large space for luggage formed by making a floor between the two top longerons which extends back to the middle bulkhead. In addition a small string rack is provided for light articles. The aeroplane is very carefully soundproofed and is normally upholstered in grey leather.

Instrument Panel

The standard instrument panel is of aluminium hinged at the base for inspection purposes with a large pigeon hole on each side for maps or other light articles ; the port one may be fitted with a special panel if extra instruments are required, a detachable inspection trap being provided in the fireproof bulkhead.

Door, Windows and Windscreen

The door is on the port side and is an improved version of that used on the Falcon. A sliding window is provided on the port side and the windscreen is moulded in one large piece of Perspex.

Ball-Bearing Controls

The controls have been modified to use ball races wherever possible to reduce friction and increase the life of the parts. Both sticks are mounted on rocker shafts which are carried in ball races on the front spar. Behind the spar the shafts are linked to a central lever. This lever is

Fig. 5.—THE HAWK TRAINER, MARK II.

The trailing edge flaps are down and the flap position indicator can clearly be seen on the instrument panel.

Fig. 6.—THE HAWK TRAINER, MARK II.

wing the top of the elevator bias lever
indicator in the top right-hand corner of

mounted on a tube which takes the movement to the rear of the rear centre section spar where a further lever is fitted which takes the aileron actuating cables. The forward portion of each rocker shaft slopes down for a distance, the stick being pivoted at the bottom to give fore and aft movement. A connecting rod runs through the part of the rocker shaft that is in the spar, joining the stick with an actuating lever for the elevator.

The two actuating levers are mounted on a cross shaft, the elevator cables being taken from the starboard side.

Elevator Bias Control

The elevator bias handle is on the spar between the two sticks and connects directly with a third lever on the cross shaft by a rod on which is mounted springs to give the necessary loading.

Rudder, Throttle and Mixture Controls

The two rudder bars are connected under the fuselage to a central lever from which run the rudder cables and the connection to the differential brake unit. There is no adjustable rudder bias. There is a throttle lever each side and a central knob for the mixture control.

Differential Control of Ailerons

The ailerons have differential action, the actuation being by chain and sprocket. The latter has a number of holes drilled in it, through three of which the actuating lever is bolted. The aileron does not extend right to the wing tip, stopping one bay short.

Landing Gear

The undercarriage consists of a single " Airdraulic " shock absorber strut with a knuckle joint to prevent the lower part from twisting. This is attached to the spar by two electron castings, the shear load being taken by a bolt through the top. The wheel is carried in a " U " shaped fork. The whole unit is faired by an easily detachable spat. A tail wheel of improved design is fitted in the same manner as on the Falcon. The rudder is horn balanced as on the Trainer.

Flap Operating Gear

The other departure from standard practice introduced in this aeroplane is the flap gear. The flaps follow normal Miles practice, but are operated by a " Theed " vacuum ram. This unit consists of a large diameter piston connected *viâ* a reservoir to the engine inlet manifold. Running the engine creates a sufficient depression in the reservoir and ram to hold the flaps down against an air speed of over 75 m.p.h. A non-return valve is fitted between the reservoir and engine which gives a reserve depression in the reservoir sufficient to operate the flaps two or

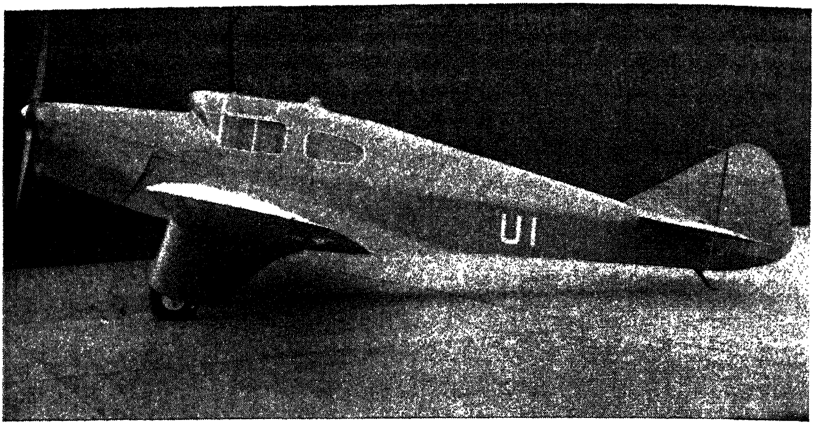


Fig. 7.—THE FALCON MAJOR.

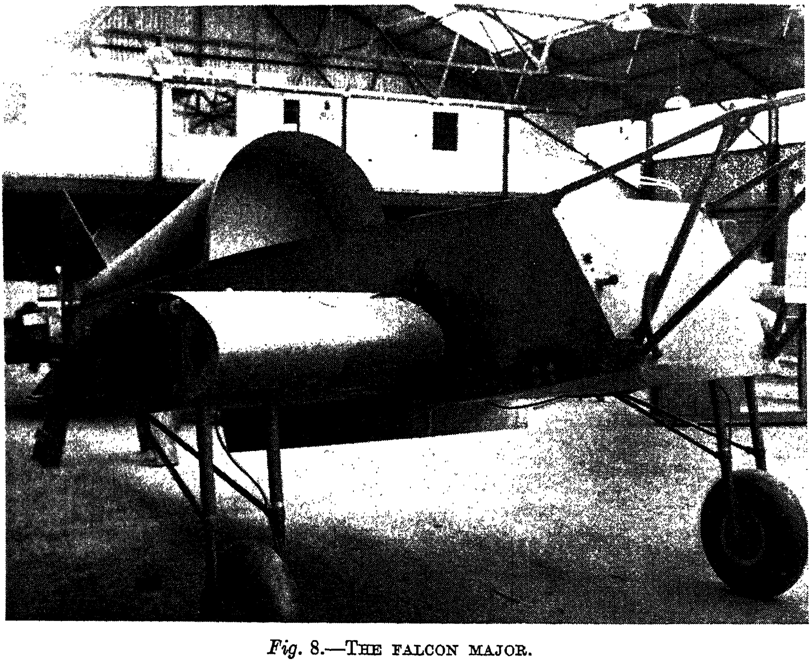


Fig. 8.—THE FALCON MAJOR.
Showing the airframe under construction.

three times with the engine off. A simple three-way cock is mounted behind the instrument panel, and a lever on the panel gives three flap positions, " down," 30 degrees down for take-off, and " up." The flaps are returned by a length of shock absorber cord.

ERECTION AND RIGGING

The erection of these aeroplanes is very simple. The fuselage and centre section are made up as one unit at the factory with the undercarriage attached. The main planes are built to fine limits and no adjustment is possible. The wing root fittings consist of four pairs of plates on the wing and on the centre section. On the wing the front pairs are in a vertical plane and the rear ones are horizontal; all those on the centre section are vertical. A permanent trunnion block with a vertical hole for the rear wing pins is fitted between each pair of rear centre section plates. The rear spar of the wing is offered up to the trunnion blocks and the wing pins are pushed through from the top and bottom. The wing tip is supported by a trestle, and the wing pins are tightened up and split pinned. The wing is then closed and the front wing pins are fitted. The aileron cables are fitted, the balance cable passing over the wing jockey pulley which must be removed to put the cable in place. The starboard wing carries the pitôt; this must be connected between the wing and centre section. This is effected by about 12 in. of P.R. hose for both static and pressure tubes, fitted in a loop to enable the wing to be folded.

The ailerons are attached to the false spar by three hinges; these are fitted at the factory, and to assemble the aileron, the piano wire hinge pins are inserted and locked by bending down the end. The folding flaps are attached to the rear spar in the same manner by two hinges.

The fin is attached to the fuselage by bolting the fin post to the stern post and the front attachment fitting to the rearmost decking bend. The tail skid attachment fitting is under the fin post, but for the tail wheel it is fitted outside. The assembly of skid or wheel unit is perfectly straightforward.

The tail plane is attached to the fuselage by four fittings, adjustments to the incidence being made on the front pair, which are provided with four settings.

The elevators can be fitted with the fin in position by facing the trailing edge forward, sliding it above the tail plane and turning it the correct way round; this procedure is necessary as the kingpost prevents it being inserted in any other manner. The hinge pins with the steel bushes in place are then fitted into the eye-bolts on the tail plane and are locked by split pins, a steel washer being placed between the eye-bolt and the pin in each case. The elevator connecting rod is attached to the kingpost and locked up.

The rudder is attached to the fin in the same way, the cables being

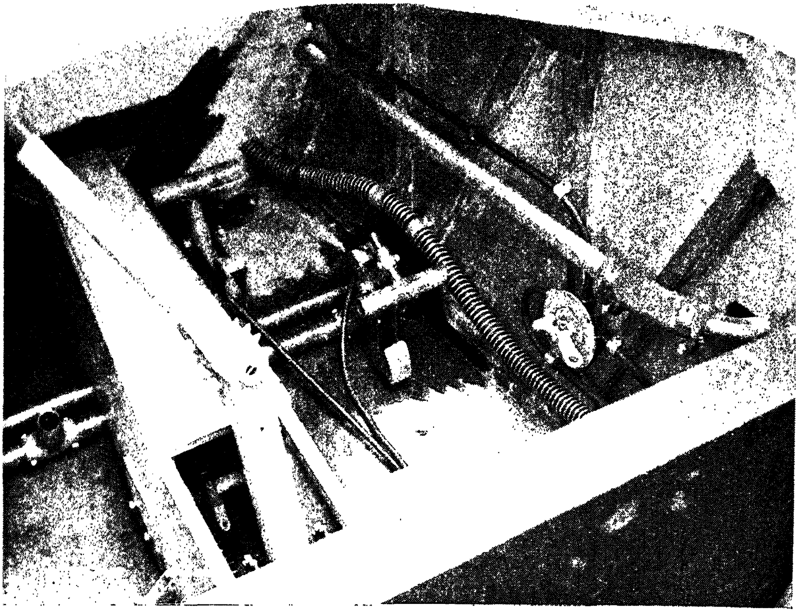


Fig. 9.—THE FALCON MAJOR.

The cockpit during construction, showing rudder pedals and control box.

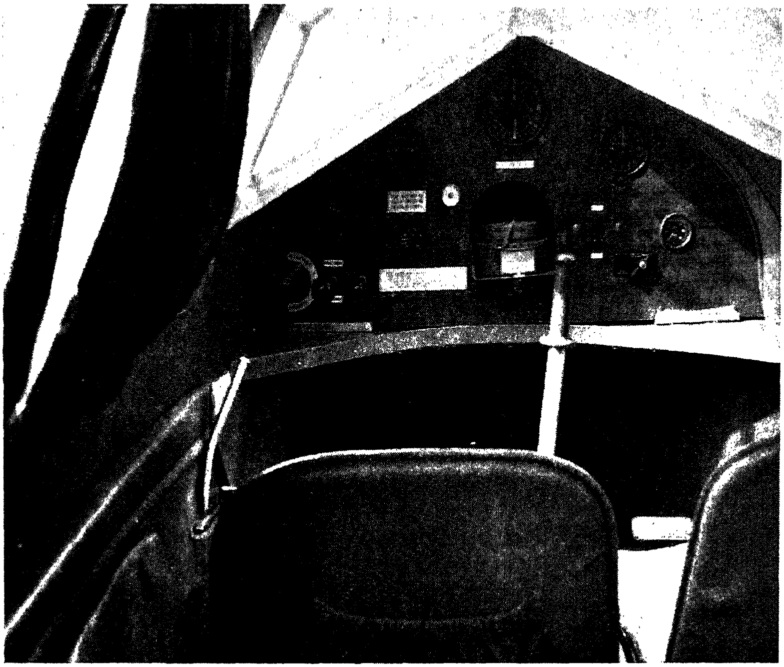
connected to the kingposts by pins according to normal practice. An aluminium fairing is fitted round the tail plane and fin by wood screws and metal threads.

The only rigging possible on these aeroplanes is the adjustment of the controls and the tail plane.

To Rig the Ailerons

First adjust the controls in the wings. These consist of a tube in the wing between the false spar and the rear spar, on which is mounted a triangular plate with three attachment points. The two at the base of the triangle take the cables and the other one takes the drop arm. Line up the two holes for the cables so that they are parallel with the tube and adjust the drop arm until the aileron is level with the trailing edge of the wing. The ailerons should be held in this position with small clamps; the actuating cables should be adjusted in the rear cockpit to take up any slack and to have the rear stick central. The balance cable should then be adjusted and all turnbuckles and shackle pins should be locked. A point to note for correct function is that the aileron should always come up to meet the stick, *i.e.*, stick to port means port aileron up.

On the Whitney Straight the procedure is the same except that the



[*By courtesy of* " *The Aeroplane.*"

Fig. 10.—THE FALCON MAJOR.

Showing the cabin.

plate for the drop arm has been replaced by a lever and sprocket which would be set so that there is $\frac{7}{8}$ in. between the centre of the tube and the centre of the pivot for the drop arm.

Elevators

These should be adjusted to give rather more " up " movement than " down." The turnbuckles for adjusting the elevator actuating cables are behind the rear spar, and no other adjustments are provided. As with the ailerons the elevators should always come up to meet the stick.

Rudder

The turnbuckles for the rudder cables are in the rear cockpit on the open aeroplanes, behind the rear spar on the Falcons and under the fuselage on the Whitney Straight. In addition, on the Falcon there is a connection between the rudder bar and the lever on the rear spar, which should be parallel.

When rigging, always make sure that all turnbuckles and fork ends are in safety.

CORRECTION OF FLYING FAULTS

Since there are no rigging adjustments the correction of flying faults is a simple matter, involving a system of trial and error.

One Wing Low

If it is reported as flying one wing low, a strip of aluminium tube ¼ in. diameter is screwed under the opposite aileron at the inner end. The exact amount required can only be found by subsequent test flying. When this is satisfactory the tube is covered by a tape doped on.

Yawing

This can be corrected on the rudder bias on all types except the Whitney Straight. On this type adjustment is effected by a strip of cord on the trailing edge taped and doped in position.

Nose and Tail Heavy

The tail plane incidence must be altered if it is so nose or tail heavy that the elevator bias is not effective at all engine speeds. For normal tail plane settings see the rigging chart. To correct nose heaviness lower the tail plane one hole and raise it to correct tail heaviness.

FLAPS

The flaps are adjusted throughout their length by fork ends and should be flush with the trailing edge of the wing when up. On the Whitney Straight there is a further adjustment which enables the flaps to be lowered 30 degrees for take-off. The fuselage flap opens forward and is therefore not required for the take-off. A lost motion is arranged so that this flap travels very slightly up into the flap well and down again without actually entering the slipstream at all.

When the lever on the instrument panel is put in the " take-off " position the " Theed " ram is open to the engine suction and the flaps are lowered to the 30 degrees position. They are unable to go any further as a stop is fitted which has a trip for the full-down position. When the lever is in the " down " position a Bowden wire from it operates the trip and the flaps, including the fuselage flap, are able to finish the full travel. There is an adjustment on the stop which requires careful setting in order that the trip may operate correctly. A small screw provides this adjustment and it should be screwed in to make the trip lighter, being then set by a locknut.

MAINTENANCE

Now that an idea has been obtained of the general construction of the aeroplane, it is possible to consider the question of care and maintenance. The efficiency of an aeroplane under all operating conditions is dependent on the care with which it is maintained. The question is best considered from the point of view of a ground engineer who is signing a daily safety certificate. Sometimes an owner, who does not require a daily safety certificate, thinks that he will save money by having the fewest inspections possible. This is not a wise policy, as trouble has usually developed before being detected, instead of using routine inspections to avoid it. If an aeroplane is not properly looked after it will have a lower second-hand value and the annual Certificate of Airworthiness will be more expensive, quite apart from the fact that it might be dangerous.

Inspections are usually called for after periods of flying, starting with a daily, then after, say, twenty-five hours, fifty hours, and in multiples of twenty-five hours until the annual C. of A. In addition to these, there is the inspection after ill usage, generally a heavy landing. Provided that an aeroplane is properly looked after it is quite safe, in cases of emergency, to exceed these times by from 5 to 10 per cent. A ground engineer should always try to anticipate trouble, his experience warning him of those points which need attention. The following general notes have been compiled with this idea in mind, in order that a clear conception may be obtained of the cause of any trouble.

General Maintenance Data

Most trouble occurs in moving parts, which fall under the two general headings of controls and landing gear, but in addition to these, cowling requires regular attention.

In the first place, cables are apt to fray where they pass through fairleads or over pulleys. If a finger is rubbed over that part of the cable which passes through the fairlead, any frayed strands will soon make themselves felt.

In order to lessen the wear in moving parts of controls, the modern tendency is to use ball races; these should be checked periodically to verify that they are not turning in the housing, for if a race is as slack as this, it is useless. In addition, if a slack race is not located by some other means, there is a chance that it may come out of the housing altogether. Races also require periodical cleaning and inspecting for split balls, after which they should be oiled or greased according to their position and work. In types where ball races are not fitted wear is noticeable far sooner. The quickest way to check for wear on a dual control unit is to hold one stick tight and see how much it is possible to move the other one. This movement will be the sum of the wear throughout the whole unit, if excessive it must be traced and the worn parts replaced. Insufficient bearing area is the usual cause, and it is soon possible to estimate which parts are likely to give trouble from this cause. Points of this description to watch are: pinning through thin gauge tubing without having it properly reinforced, pins in thin plate fittings, high loads and large movements taken on comparatively low gauge plate and moving parts in unbushed dural or aluminium.

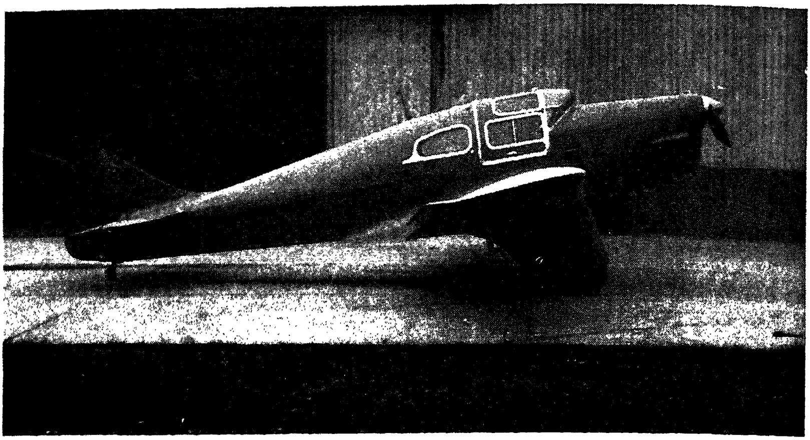


Fig. 11.—THE FALCON VI.

As important as the controls are those units which take the landing loads. This heading covers the undercarriage, the tail skid or wheel and those members of the airframe to which the loads are transmitted. An undercarriage does not give much trouble in the early part of its life

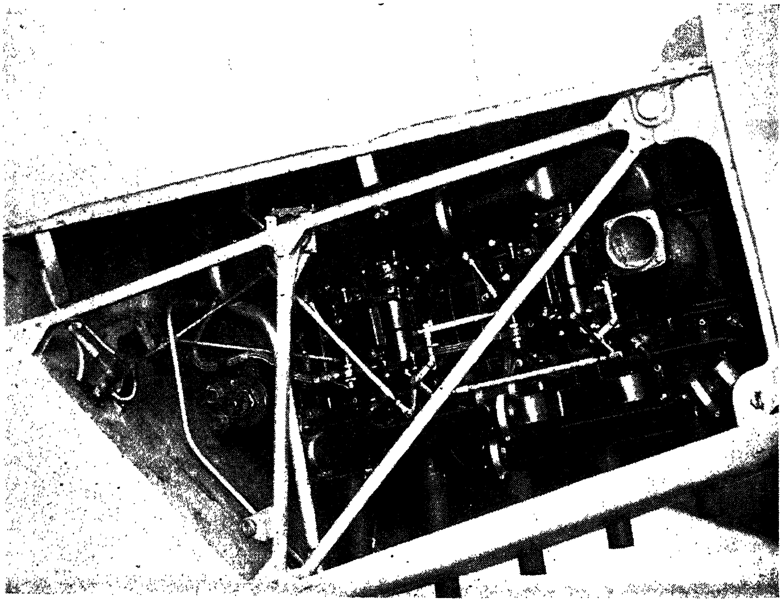


Fig. 12.—THE FALCON VI.

Showing the installation of the Gipsy VI engine, old-type cowling fitted.

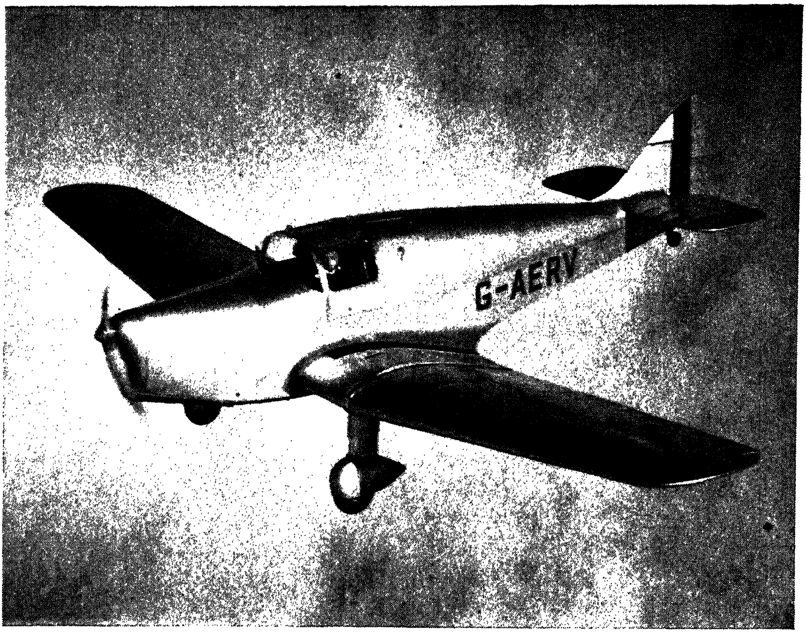


Fig. 13.—THE MILES WHITNEY STRAIGHT.
Note the single-piece Perspex windscreen and the latest type engine cowling.

provided that normal landings are made. The compression leg members will eventually score and wear and bolts taking heavy loads may be bent or sheared. If long struts are incorporated they should be checked for bow. Continual hammering will also tend to elongate bolt holes in the attachment fittings.

A tail skid or wheel is usually more troublesome than the undercarriage. Skid springs sometimes break, the check cable which is fitted in case of this happening, only lasting for a very short time. Unless detected in time this often entails a repair to the bottom rudder bend. If an internally fitted check cable is replaced, care must be taken to see that it is long enough to allow the spring full travel, without being too long, when it will get nipped in the coils of the spring. For this reason check cables are now fitted outside the spring. Skidshoes break or wear out fairly often, but their replacement is a very simple matter, since they are held in place by only two bolts. In time, the fulcrum pin and its bearing get badly worn by hammering. The loads on the skid can be very high, and if there have been too many such loadings, the longerons in the tail bay may suffer; the lower ones in particular should be examined for splits or compression shakes. Tail wheels vary greatly in type, but usually suffer from elongated bolt holes, cracked welds if built up this

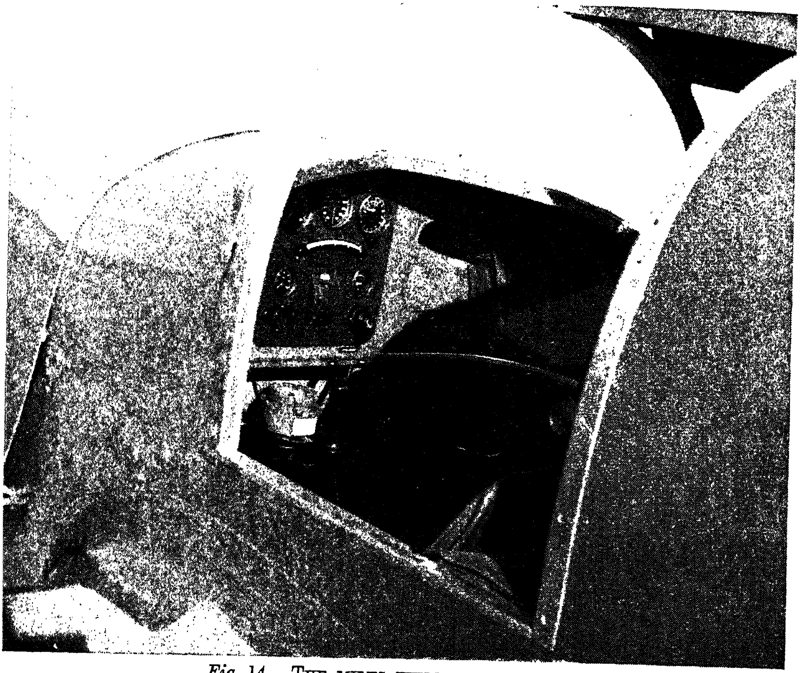


Fig. 14.—THE MILES WHITNEY STRAIGHT.

The interior of the cabin, showing two sticks, compass and instrument panel. The flap operating lever is in the centre of the panel and the three positions can clearly be seen.

way or even from complete failure if loads have been too heavy. This latter, however, may point to indifferent maintenance, as some distortion will take place before failure.

One point to which particular attention should be paid when refitting bolts is the question of the load involved. Where a shear load is taken by a bolt, no thread should be in bearing. There are two reasons for this. Firstly, that although the bolt has been stressed on its outside diameter, only the core diameter of the thread will be doing any work. Secondly, even if the bolt is still strong enough there is only a line bearing instead of an area bearing; *i.e.*, the apex of the thread. As a result, wear occurs very rapidly, followed by hammering; it is then a very short step to an elongated hole in which case the fitting will also have to be scrapped.

Cowling and fairings of light gauge aluminium usually crack in service. This is because they are very difficult to support properly against vibration which tends to work-harden the material. When a crack is found it can be stopped by drilling a sixteenth diameter hole at the extreme end and removing the burrs. If the hole is not drilled at the extreme end, the crack will continue to spread. A small crack that has been stopped by this means can be safely left until it is convenient to remove the cowl for repair.

Daily Maintenance on Miles Types

On a daily inspection it is best to work methodically round the aeroplane, following a standard routine.

The airscrew and cowling should be examined for faults in accordance with normal practice.

If the wings are folded make sure that nothing has been left in the tank bays, as these form a very convenient resting place for tools. Then close the wings, making sure that the piano wire locking pins are correctly in place through the wing pins. Examine the wings for any holes in the plywood for, although rare, there are many ways in which they may occur. Look at the pitôt post under the starboard wing, for careless people sometimes forget its existence and catch it on some obstruction ; this is particularly liable to happen when moving the aeroplane in a crowded hangar. Check the cable runs to the ailerons and then close and lock the folding flaps. The undercarriage should be examined, and if the wheels are of the plain bearing type they should be greased, as any trouble from lack of lubricant would be very serious. The tyres should be examined for cuts and if necessary the pressures should be taken. Trestle up the rear of the fuselage and examine the tail skid or wheel, skid spring and tail bay of the fuselage as outlined already. The tail unit and all controls at the rear of the fuselage should be examined at the same time. The cockpits should now be examined, first of all checking over the controls. If the aeroplane is to be flown solo, the second stick and the connecting rod between the two rudder bars should be removed. All subsidiary controls and instruments should be checked for function and condition, including flaps when these are fitted. Brakes, if fitted, should be tested daily by taxi-ing. The daily inspection is a simple operation, the purpose of which is to verify that no damage or excessive wear has developed during the previous day's flying.

TWENTY-FIVE HOUR INSPECTION

A twenty-five hour inspection should be far more thorough than a daily and should be made an opportunity for doing any necessary work. It can be tackled in two ways, depending on the amount of flying. If the aeroplane is not in constant use it can be withdrawn from service for a day and the whole check can be made at once. However, if it is in constant use at a club or school, it is advantageous to work the twenty-five hour check in with the dailies, spread out over a week, thus avoiding the need of taking the aeroplane off service. In both cases it is better to sectionalise the work, and the following method is suggested : wings

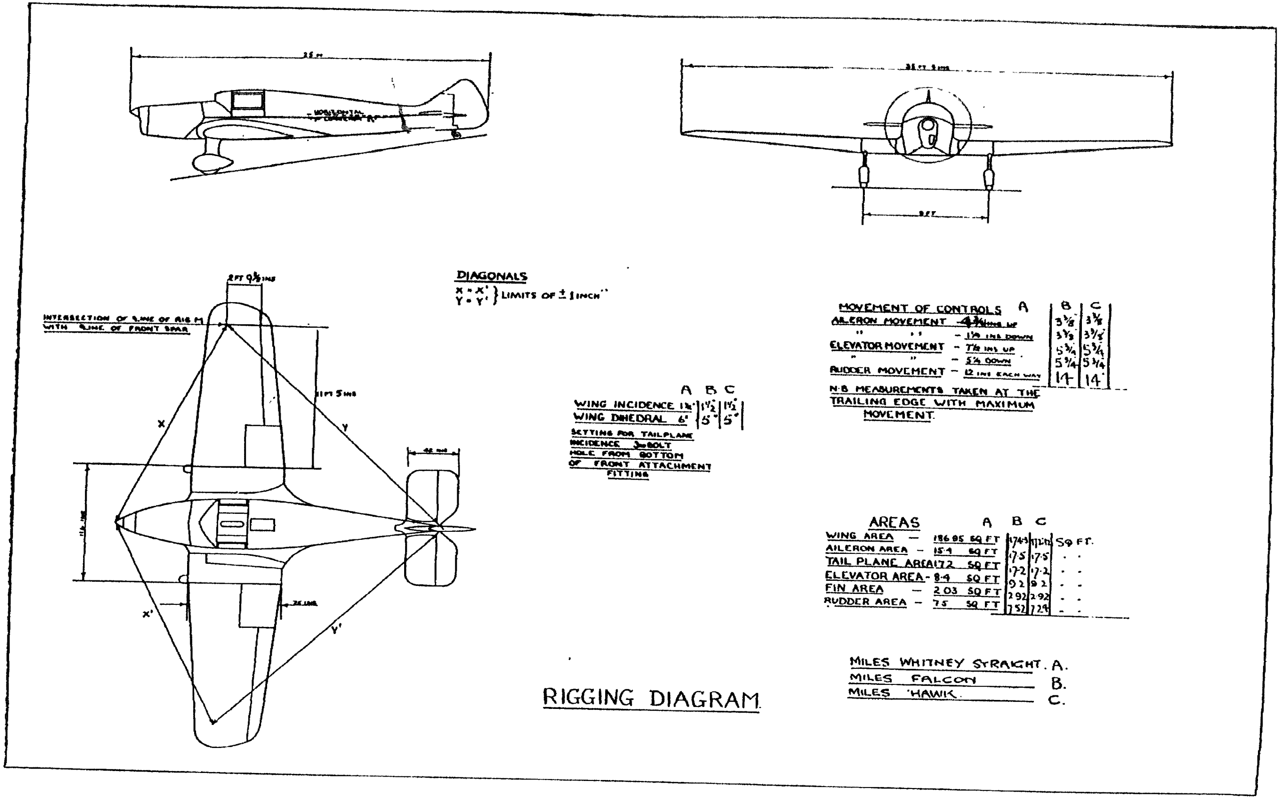

25 FT
HORIZONTAL DATUM LINE
33 FT 5 INS
9 FT
2 FT 9⅝ INS
INTERSECTION OF ¼ LINE OF RIB M WITH ¼ LINE OF FRONT SPAR
11 FT 5 INS
X
Y
X'
Y'
DIAGONALS
X = X'
Y = Y' } LIMITS OF ± ⅛ INCH
A B C
WING INCIDENCE 1½° | 1½° | 1½°
WING DIHEDRAL 6° | 5° | 5°
SETTING FOR TAILPLANE INCIDENCE 3rd BOLT HOLE FROM BOTTOM OF FRONT ATTACHMENT FITTING
MOVEMENT OF CONTROLS A B C
AILERON MOVEMENT – 4⅜ INS UP | 3⅞" | 3⅞"
" " – 1⅞ INS DOWN | 3⅞" | 3⅞"
ELEVATOR MOVEMENT – 7⅛ INS UP | 5¾ | 5¾
" " – 5¼ DOWN | 5¾ | 5¾
RUDDER MOVEMENT – 12 INS EACH WAY | 14 | 14"
N.B. MEASUREMENTS TAKEN AT THE TRAILING EDGE WITH MAXIMUM MOVEMENT.
AREAS A B C
WING AREA – 186.85 SQ FT | 174.5 | 172.2 | SQ FT.
AILERON AREA – 15.4 SQ FT | 17.5 | 17.5 | "
TAIL PLANE AREA 17.2 SQ FT | 17.2 | 17.2 | "
ELEVATOR AREA – 8.4 SQ FT | 9.2 | 9.2 | "
FIN AREA – 2.03 SQ FT | 2.92 | 2.92 | "
RUDDER AREA – 7.5 SQ FT | 7.52 | 7.29 | "
MILES WHITNEY STRAIGHT A.
MILES FALCON B.
MILES HAWK. C.
RIGGING DIAGRAM

Fig. 15.—RIGGING DIAGRAM.

and centre section, landing gear, controls, fuselage and tail unit, instruments and cockpits, and equipment and appearance.

CIRRUS HAWK

Wings and Centre Section

1. Fold back the wings, ensuring that they are properly supported from the tail plane by the wing hooks. If they are left unsupported the weight of the wing has a tendency to twist the rear centre section spar. Also make sure that the folding flap is properly secured, for if this should fall when the wing is folded, the top centre section skin would be damaged.
2. Clean out the tank bay and see that any fuel which may have been spilled during filling is draining away properly.
3. Try the wing pins in the spar plates for excess play, both individually and with the wings in place. When this play reaches approximately 0·003 in., the holes are reamed out to 0·005 in. and oversize pins are fitted. Pins are also obtainable at 0·010 in. and 0·015 in. oversize. All wing pins are made of high tensile steel, the oversize ones being obtainable under different part numbers.
4. Wing pins should be examined for scoring, and if this is found, any burrs should be carefully removed from the plates with a scraper.
5. Spread the wings and lock the wing pins.
6. Examine the aileron cable runs through the centre section and wing with particular attention to the rubbing points at the fairleads and pulley.
7. Make sure that the fairleads are tight.
8. A small amount of slackness in the cables, due to stretch, may be taken up by the balance cable turnbuckle on the starboard side under the folding flap. If there is too much, however, the aileron droop will become excessive and adjustment must then be made evenly on both actuating cable turnbuckles in the rear cockpit. Relock turnbuckles.
9. Lubricate all moving parts with light machine oil, noting particularly that the pulley is free over which the balance cable passes.
10. Check all fittings for tightness in summer conditions, as shrinkage may take place in the timber members. This is most important on new aeroplanes. The practice of fitting shrinkage washers has now been adopted, which lessens this trouble considerably.
11. See that all locking is secure, close and lock the folding flaps, replace all inspection traps and refit the wing bands.

Landing Gear

1. Trestle the aeroplane up with one trestle on each side under the centre section front spar and one under the fuselage at the rear bulkhead.
2. Check over all the joints for wear at the pins and holes : trouble, however, will only be experienced here after long periods.

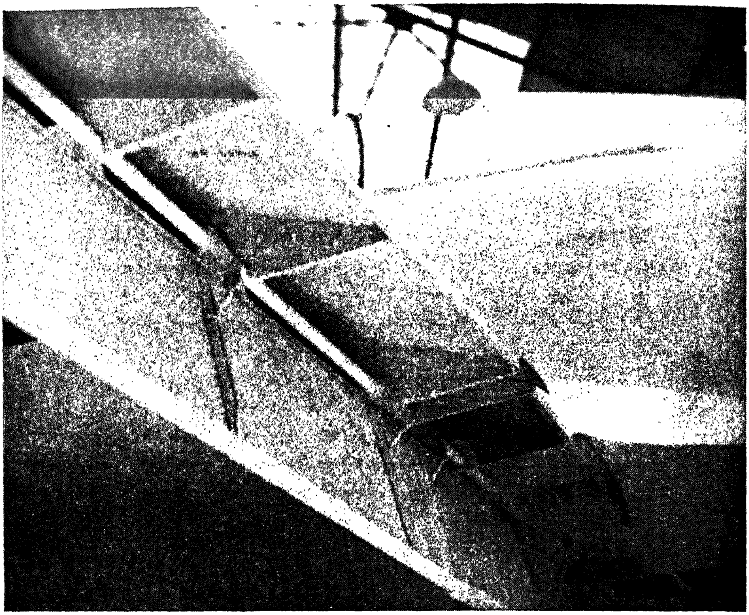


Fig. 16.—THE MILES HAWK.

Showing the trailing edge flaps. The torque tubes, levers and links can be seen. Adjustment to the flaps is made on the fork ends.

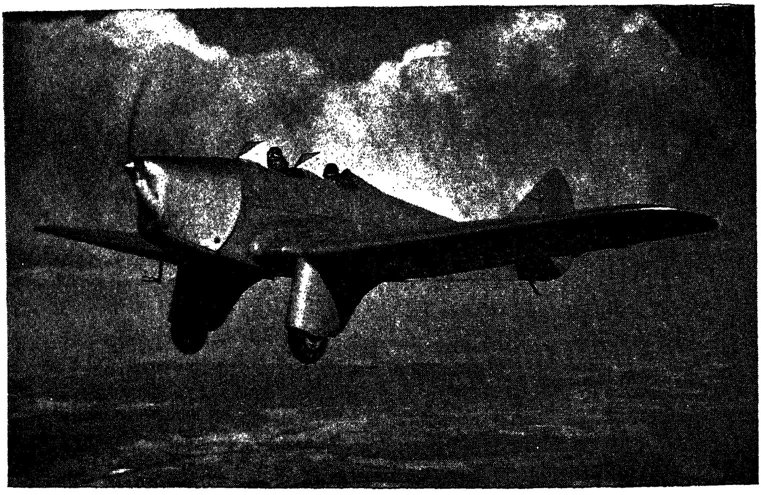


Fig. 17.—THE HAWK TRAINER, MARK II.

Note the pitôt post under the starboard wing and the oil tank filler cap on the port side of the centre section.

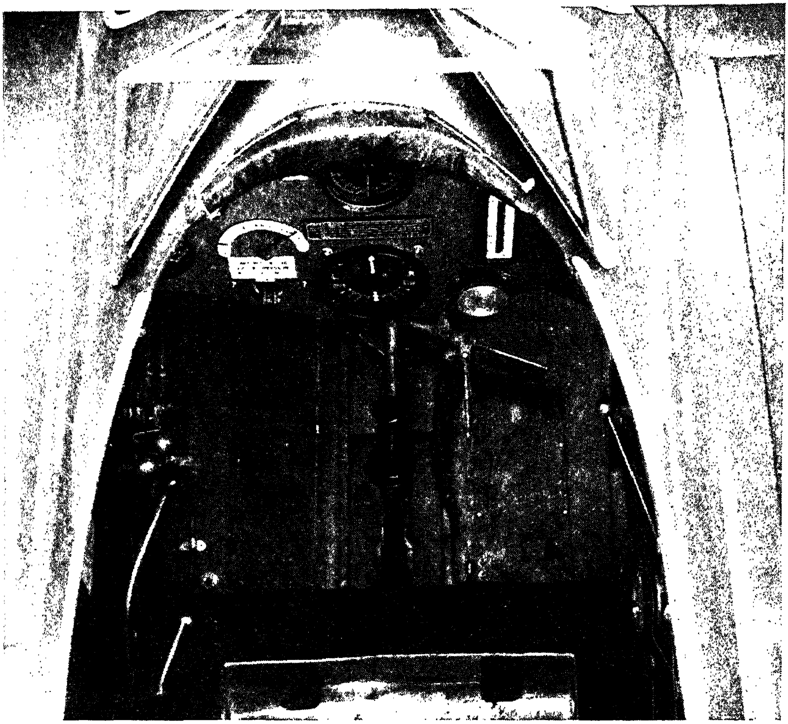


Fig. 18.—THE HAWK TRAINER.

Showing the rear cockpit. Note the rudder bias knob on the instrument panel and the bias spring coupled direct to the bar. The rudder cable turnbuckles can also be seen.

3. Clean down the sliding tube of the compression leg and re-grease; if this is not done partial seizure may occur and the tube will wear much faster, due to abrasion.

4. Examine the hard wood block on which the top compression leg is mounted, as this may be crushed after a series of heavy landings.

5. The radius rod attachment fitting on the rear spar requires examination, cracks appearing both along the welding and radially from the holes for the bolts through the spar.

Tail Skid

1. Remove the two inspection panels in the rear fuselage bay to examine the spring and check cable as mentioned previously.

2. Try the play in the skid fulcrum and re-grease.

3. If the aeroplane has been making heavy landings, examine the longerons, especially at the bolt holes for the bottom skid attachment fitting.

Controls

In addition to the daily inspection of flying controls the following points should be examined at the twenty-five hour check :—

1. The rudder bars should be checked for play at the pivot. In earlier types the spider, on which the bar is mounted, has no bushing, so that wear may become excessive.

2. The rear rudder bar may become bowed, owing to the pilot either standing on it or applying his brakes too strenuously. Should this become excessive the rudder bar must be replaced.

3. Examine the locking wire on the rudder cable turnbuckles ; these are placed in the cockpit for ease of adjustment and sometimes get damaged by the pilot's feet.

4. Check all cables at the points where they pass through the spars and bulkheads.

5. On the control unit excess wear will eventually occur at the pivot point of the flitch plates which carry the stick socket.

6. Check rudder and elevator kingposts for slackness due to shrinkage.

7. Clean and oil all flying controls.

8. Examine engine controls for freedom of movement, and control rods for chafing at points where they pass through the bulkheads ; then lubricate them with light machine oil.

Fuselage and Tail Unit

1. Examine the engine bearers and front bottom bay for oil soakage and cracks or splits due to engine vibration.

2. Clean down the engine bay and under the fuselage with a rag soaked in petrol to remove any oil.

3. Examine the cowling and repair any cracks that are too bad for drilling.

4. Examine the longeron strap plates which bridge the gap cut in the bottom longerons for the centre section spars, which should be a tight fit in the fuselage. A hard wood block is fitted between the longeron butt ends to take compression loads. A combination of shrinkage and heavy landings may cause a strap plate to become bowed. To avoid this the hard wood block must be kept a tight fit.

5. Examine the cockpit floor for damage.

6. The top half of the bulkhead at the back of the rear cockpit is sometimes pushed back into the luggage locker. This has been overcome on later types by making a 1 in. lap joint over the lower half of the bulkhead.

7. The tail bay requires regular attention as has been previously outlined in the section dealing with tail skids.

Tail Unit

1. Grease all hinge pins and examine the locking.

2. Grasp one tip of the tail plane and move it gently ; it should be

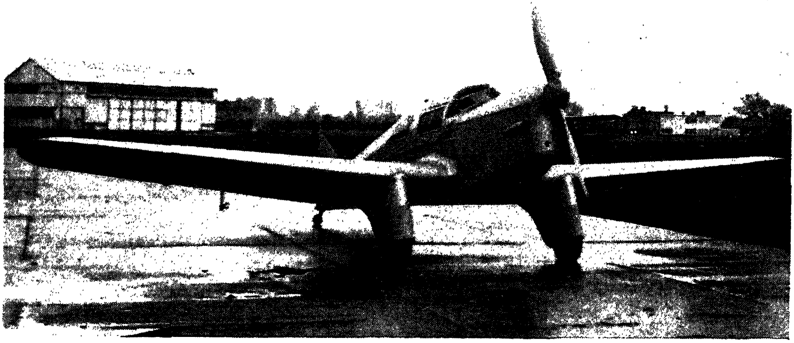


Fig. 19.—THE FALCON VI.

The aeroplane in this picture is fitted with the old-type engine cowling.

reasonably rigid and should tend to twist the rear of the fuselage. If any play is found it should be investigated at the attachment fittings, or failing this, at the internal bracing.

3. If a bend has been slightly damaged, usually on the rudder, this should be repaired.

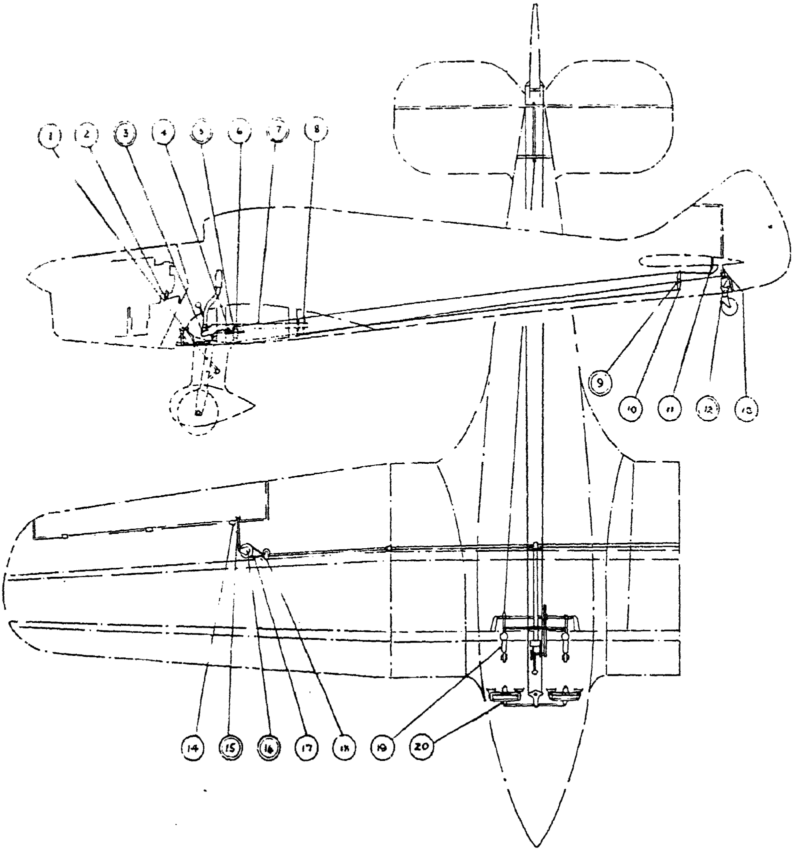
4. All the fabric should be examined. A hole is sometimes worn in the top fabric of the tail plane over the eyebolts for the wing support hooks ; this only requires a 1 in. square patch doped on.

Instruments and Cockpits

Instruments and their connections require checking for function at every twenty-five hour inspection. It is only intended here to deal very briefly with those instruments which are fitted as standard to all Miles types. These standard instruments are air-speed indicator, engine-speed indicator or rev. counter, altimeter, and oil pressure gauge. Extra instruments are often fitted, but form too wide a subject to be dealt with here.

Air-speed Indicator

This is connected to the pitôt.head by lengths of aluminium tubing with rubber tube connections between the wing and centre section, to allow for the wing folding, and also to the instrument itself. Test for function by applying a steady pressure to the pressure side of the pitôt, and observe if the instrument gives a steady reading. If the needle falls back very slowly no action need be taken, but it should be checked



g. 20.—THE WHITNEY STRAIGHT.
Lubrication diagram.

more frequently. Should it fall back quickly there is a leak on the pressure side which must be traced. If a pilot reports that the instrument is not reading, there are four possible causes :—

1. The pressure tube of the pitôt head may be blocked by dirt or some other foreign body.

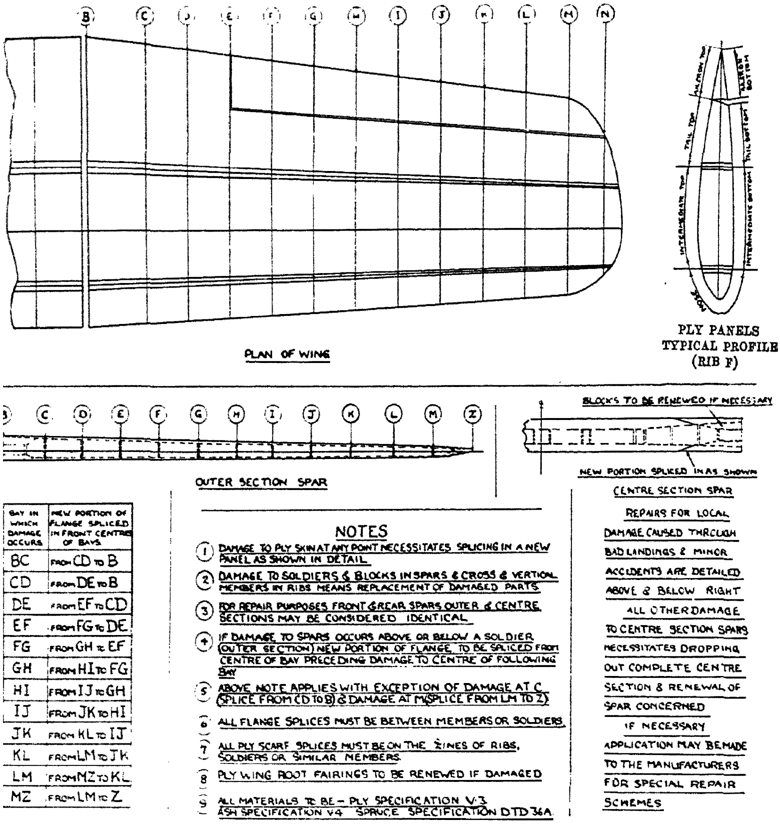
2. A tube may have fractured on the pressure side.

3. The small holes in the static side of the pitôt head may be blocked, although this is not so likely.

4. The instrument may be faulty, in which case it must be returned to the maker for repair.

Rev. Counters

These suffer from "hunting," that is, a very rapid flickering of the needle in place of a steady reading. This is usually caused by the inner



BAY IN WHICH DAMAGE OCCURS	NEW PORTION OF FLANGE SPLICED IN FRONT CENTRES OF BAYS
BC	FROM CD TO B
CD	FROM DE TO B
DE	FROM EF TO CD
EF	FROM FG TO DE
FG	FROM GH TO EF
GH	FROM HI TO FG
HI	FROM IJ TO GH
IJ	FROM JK TO HI
JK	FROM KL TO IJ
KL	FROM LM TO JK
LM	FROM MZ TO KL
MZ	FROM LM TO Z

NOTES

① DAMAGE TO PLY SKIN AT ANY POINT NECESSITATES SPLICING IN A NEW PANEL AS SHOWN IN DETAIL

② DAMAGE TO SOLDIERS & BLOCKS IN SPARS & CROSS & VERTICAL MEMBERS IN RIBS MEANS REPLACEMENT OF DAMAGED PARTS

③ FOR REPAIR PURPOSES FRONT & REAR SPARS OUTER & CENTRE SECTIONS MAY BE CONSIDERED IDENTICAL

④ IF DAMAGE TO SPARS OCCURS ABOVE OR BELOW A SOLDIER (OUTER SECTION) NEW PORTION OF FLANGE TO BE SPLICED FROM CENTRE OF BAY PRECEDING DAMAGE TO CENTRE OF FOLLOWING BAY

⑤ ABOVE NOTE APPLIES WITH EXCEPTION OF DAMAGE AT C (SPLICE FROM CD TO B) & DAMAGE AT M (SPLICE FROM LM TO Z)

⑥ ALL FLANGE SPLICES MUST BE BETWEEN MEMBERS OR SOLDIERS.

⑦ ALL PLY SCARF SPLICES MUST BE ON THE LINES OF RIBS, SOLDIERS OR SIMILAR MEMBERS.

⑧ PLY WING ROOT FAIRINGS TO BE RENEWED IF DAMAGED

⑨ ALL MATERIALS TO BE – PLY SPECIFICATION V·3 ASH SPECIFICATION V4 SPRUCE SPECIFICATION DTD 36A.

REPAIRS FOR LOCAL DAMAGE CAUSED THROUGH BAD LANDINGS & MINOR ACCIDENTS ARE DETAILED ABOVE & BELOW RIGHT

ALL OTHER DAMAGE TO CENTRE SECTION SPARS NECESSITATES DROPPING OUT COMPLETE CENTRE SECTION & RENEWAL OF SPAR CONCERNED

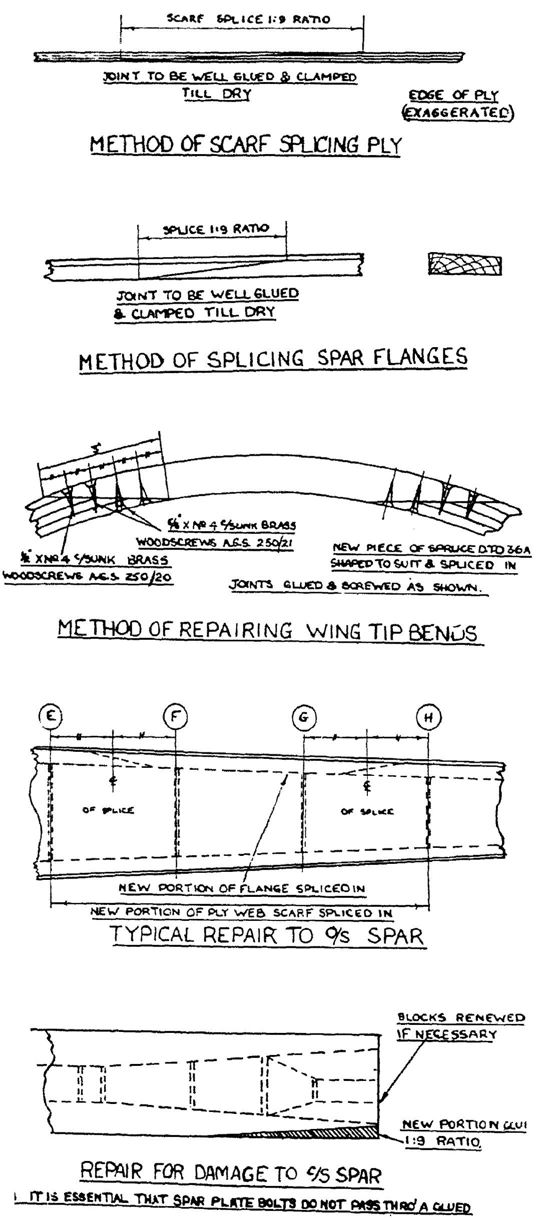
IF NECESSARY APPLICATION MAY BE MADE TO THE MANUFACTURERS FOR SPECIAL REPAIR SCHEMES

Fig. 21A.—STANDARD WING REPAIR SCHEME (SEE ALSO FIG. 21B)

driving cable binding on the flexible outer casing, as a result of which the instrument is driven in a series of jerks; this is caused by the drive being taken round a bend of too sharp a radius, the minimum requirements being a 9 in. radius. If the instrument becomes extremely erratic or stops working altogether it can usually be traced to a broken drive cable, in which case the whole flexible drive should be replaced.

Altimeter

This is a self-contained unit, therefore only the maker or specially licenced ground engineer can repair it. The two more common faults found here are a loose dial, which moves with the engine vibration, and a broken dial actuating knob, which although small in themselves render the instrument ineffective.


SCARF SPLICE 1:9 RATIO
JOINT TO BE WELL GLUED & CLAMPED TILL DRY
EDGE OF PLY (EXAGGERATED)
METHOD OF SCARF SPLICING PLY
SPLICE 1:9 RATIO
JOINT TO BE WELL GLUED & CLAMPED TILL DRY
METHOD OF SPLICING SPAR FLANGES
5"
⅝" X No 4 C/SUNK BRASS WOODSCREWS A.G.S. 250/21
⅝" X No 4 C/SUNK BRASS WOODSCREWS A.G.S. 250/20
NEW PIECE OF SPRUCE D.T.D. 36A SHAPED TO SUIT & SPLICED IN
JOINTS GLUED & SCREWED AS SHOWN.
METHOD OF REPAIRING WING TIP BENDS
E
F
G
H
℄ OF SPLICE
℄ OF SPLICE
NEW PORTION OF FLANGE SPLICED IN
NEW PORTION OF PLY WEB SCARF SPLICED IN
TYPICAL REPAIR TO O/S SPAR
BLOCKS RENEWED IF NECESSARY
NEW PORTION GLUED 1:9 RATIO
REPAIR FOR DAMAGE TO C/S SPAR
IT IS ESSENTIAL THAT SPAR PLATE BOLTS DO NOT PASS THRO' A GLUED

g. 21B.—STANDARD WING REPAIR SCHEME (SEE ALSO FIG. 21A).

Oil Pressure Gauge

Examine the connection between the engine and the gauge regularly, as any failure would cause complete loss of oil from the engine.

Cockpits

Trouble in the cockpits will not be very serious, as all controls and structure have already been considered. All that remains is to keep them as neat and clean as possible, making good any slight damage that may occur.

Equipment

The equipment is normally confined to safety belts, cushions, and such movable gear as cockpit and airscrew covers.

1. Safety belts. These are anchored to the airframe by 15 cwt. cables; in time the serving on the splices becomes frayed and requires replacing.

2. If a set of lap straps are fitted,

the split pin by which the clasp is fastened should be checked for ease of entry.

3. If aerobatic harness is fitted, the locking pin, which is of the three-pronged type, should also be tried for ease of entry.

4. If cockpit covers have been used they should be dried out before putting away, and any holes should be patched.

Appearance

The condition of an aeroplane is judged by its appearance, it is therefore worth while to touch up the paintwork and generally make it look well-cared for.

HAWK MAJOR AND TRAINER MARK II

Wings and Centre Section

The same points apply as for the Cirrus Hawk, with the addition of the oil tank on the centre section. These very rarely leak, and trouble is confined to the filler cap. This fits into a well and has an aluminium plate on top which comes flush with the outer surface of the tank ; two holes are drilled in this plate for unscrewing the cap and a special key is provided on the handle of the wing pin extractor. If this is not used or is used carelessly, the holes become elongated, and a new plate is needed.

Landing Gear

The same routine applies here as for the Cirrus Hawk in items 1, 2, 3 and 5.

4. The top compression leg attachment fitting is carried on the front spar plate bolts and does not usually give trouble.

6. For inspection purposes the front part of the spat is detachable. It is necessary, in wet weather, to clean out the rear of the spats each day as a quantity of mud collects there.

Tail Skid

This is the same as for the Cirrus Hawk.

Controls

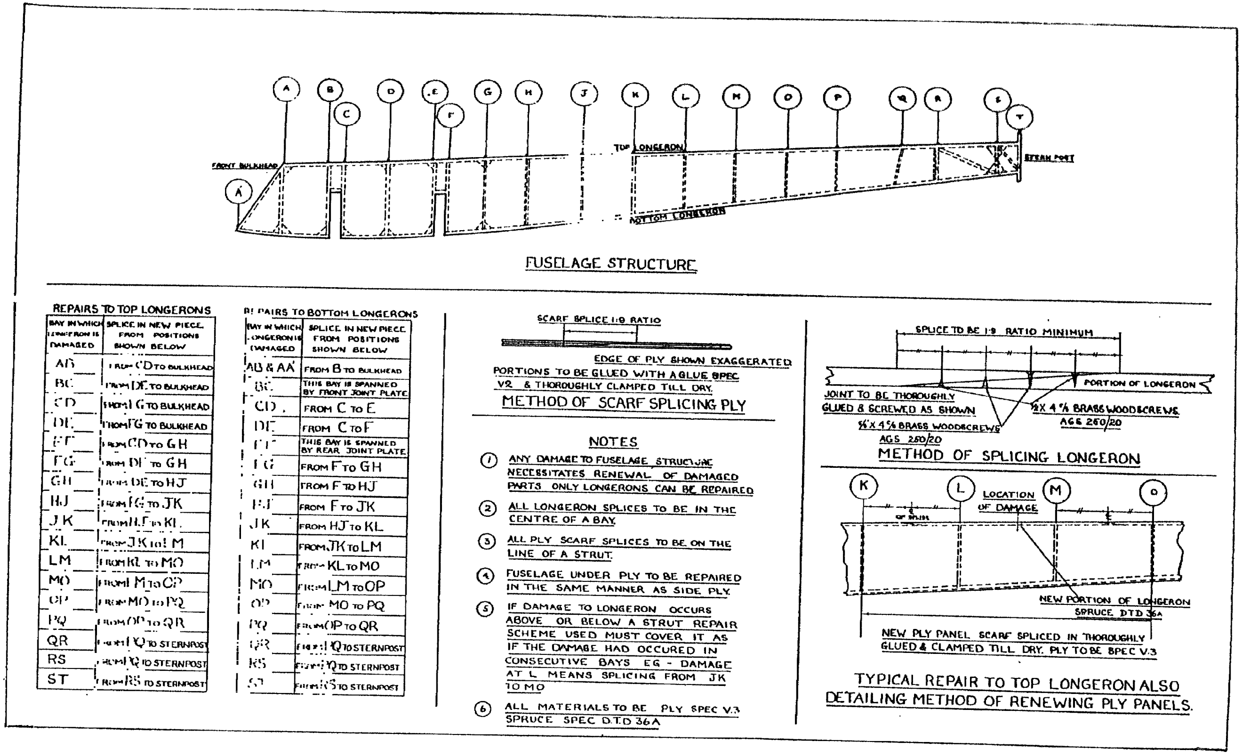
1 to 8 as for the Cirrus Hawk.

9. The stick used in the Mark II Trainer is longer than that used on the Cirrus Hawk and Hawk Major and should only be used on this aeroplane.

10. The flap gear requires checking for wear in the pins at all joints and in the taper pins attaching the various levers to the torque tubes.

11. The hinge of the fuselage flap should be examined, for this flap shuts forwards into the slipstream, and suffers most if the aeroplane is flown too fast with the flaps down.

12. On the Mark II the hydraulic pump and ram should be examined for leaks.


A
B
C
D
E
F
G
H
J
K
L
M
O
P
Q
R
S
T
A'
FRONT BULKHEAD
TOP LONGERON
BOTTOM LONGERON
STERN POST
FUSELAGE STRUCTURE
SCARF SPLICE 1:9 RATIO
EDGE OF PLY SHOWN EXAGGERATED
PORTIONS TO BE GLUED WITH A GLUE SPEC V2 & THOROUGHLY CLAMPED TILL DRY.
METHOD OF SCARF SPLICING PLY
SPLICE TO BE 1·9 RATIO MINIMUM
PORTION OF LONGERON
JOINT TO BE THOROUGHLY GLUED & SCREWED AS SHOWN
⅛"X 4 ⅛ BRASS WOODSCREWS AGS 250/20
⅛"X 4 ⅛ BRASS WOODSCREWS AGS 250/20
METHOD OF SPLICING LONGERON
K
L
M
O
LOCATION OF DAMAGE
℄ OF SPLICE
NEW PORTION OF LONGERON SPRUCE DTD 36A
NEW PLY PANEL SCARF SPLICED IN THOROUGHLY GLUED & CLAMPED TILL DRY. PLY TO BE SPEC V.3
TYPICAL REPAIR TO TOP LONGERON ALSO DETAILING METHOD OF RENEWING PLY PANELS.

REPAIRS TO TOP LONGERONS

BAY IN WHICH LONGERON IS DAMAGED	SPLICE IN NEW PIECE FROM POSITIONS SHOWN BELOW
AB	FROM CD TO BULKHEAD
BC	FROM DE TO BULKHEAD
CD	FROM FG TO BULKHEAD
DE	FROM FG TO BULKHEAD
EF	FROM CD TO GH
FG	FROM DE TO GH
GH	FROM DE TO HJ
HJ	FROM FG TO JK
JK	FROM HJ TO KL
KL	FROM JK TO LM
LM	FROM KL TO MO
MO	FROM LM TO OP
OP	FROM MO TO PQ
PQ	FROM OP TO QR
QR	FROM PQ TO STERNPOST
RS	FROM PQ TO STERNPOST
ST	FROM RS TO STERNPOST

REPAIRS TO BOTTOM LONGERONS

BAY IN WHICH LONGERON IS DAMAGED	SPLICE IN NEW PIECE FROM POSITIONS SHOWN BELOW
AB & AA'	FROM B TO BULKHEAD
BC	THIS BAY IS SPANNED BY FRONT JOINT PLATE
CD	FROM C TO E
DE	FROM C TO F
EF	THIS BAY IS SPANNED BY REAR JOINT PLATE
FG	FROM F TO GH
GH	FROM F TO HJ
HJ	FROM F TO JK
JK	FROM HJ TO KL
KL	FROM JK TO LM
LM	FROM KL TO MO
MO	FROM LM TO OP
OP	FROM MO TO PQ
PQ	FROM OP TO QR
QR	FROM PQ TO STERNPOST
RS	FROM PQ TO STERNPOST
ST	FROM RS TO STERNPOST

NOTES

① ANY DAMAGE TO FUSELAGE STRUCTURE NECESSITATES RENEWAL OF DAMAGED PARTS ONLY LONGERONS CAN BE REPAIRED

② ALL LONGERON SPLICES TO BE IN THE CENTRE OF A BAY.

③ ALL PLY SCARF SPLICES TO BE ON THE LINE OF A STRUT.

④ FUSELAGE UNDER PLY TO BE REPAIRED IN THE SAME MANNER AS SIDE PLY.

⑤ IF DAMAGE TO LONGERON OCCURS ABOVE OR BELOW A STRUT REPAIR SCHEME USED MUST COVER IT AS IF THE DAMAGE HAD OCCURED IN CONSECUTIVE BAYS EG - DAMAGE AT L MEANS SPLICING FROM JK TO MO

⑥ ALL MATERIALS TO BE PLY SPEC V.3 SPRUCE SPEC D.T.D 36A

Fig. 22.—STANDARD FUSELAGE REPAIR SCHEMES.

13. The pump looses fluid slowly and should be topped up if necessary with Arctic grade oil.

14. The mass balances to the control surfaces on earlier aeroplanes had the lead weights attached by bolts; these weights tend to work loose under vibration. On more recent ones the weights are cast directly on to the arm and give no trouble.

Remainder of the schedule as for Cirrus Hawk.

FALCON MAJOR AND VI

Wings and Centre Section

The same schedules apply as for the Hawk Major.

Landing Gear

The same schedules apply for the Falcon Major as for the Hawk Major, but the Falcon VI is fitted with a tail wheel.

Tail Wheel

1. Check all pivot bolts for wear and re-grease.
2. Check the wheel and castor action for freedom of movement and grease.
3. The bracket against which the compression rubber works should be examined for distortion or cracking. On early aeroplanes the bracket fitted would not stand up to continual heavy loads. This trouble has now been overcome by strengthening the fitting along the free edges of the side plates.

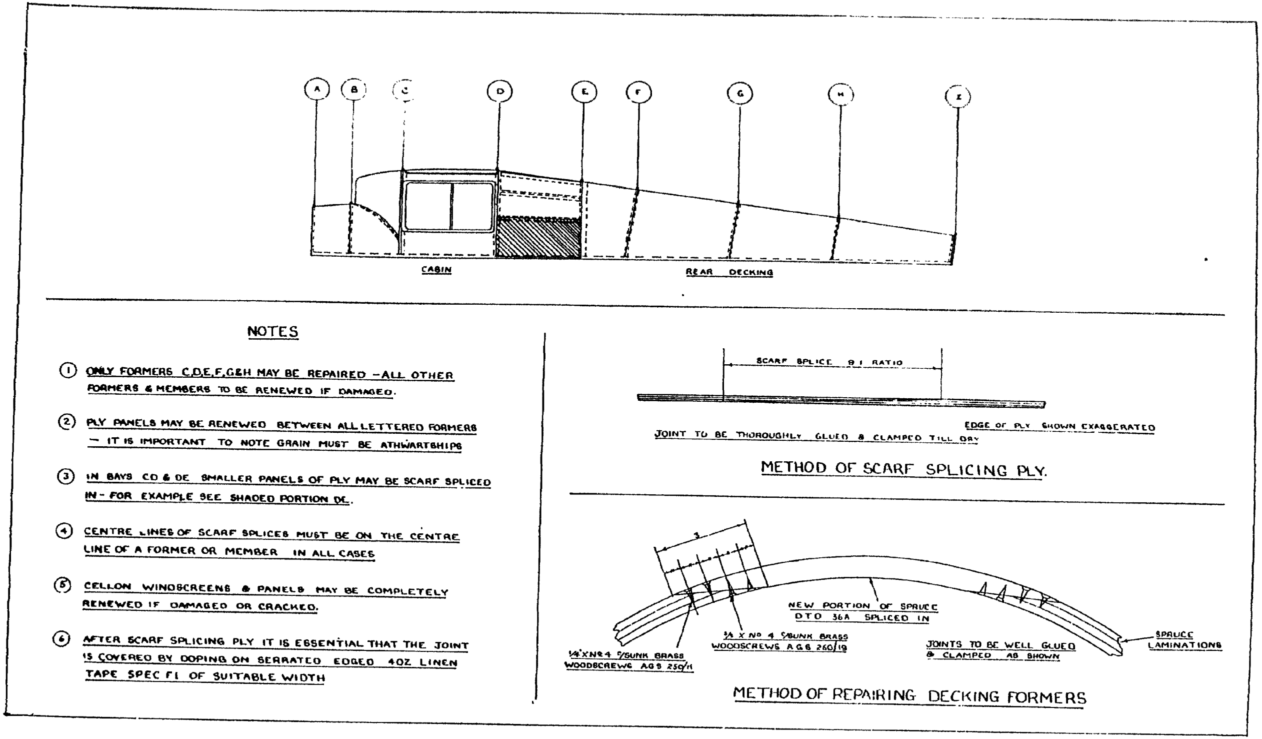
Controls

1. Remove the covers from the control boxes, which are completely covered in, a leather bag being laced round the stick to allow for free movement. It is necessary to enclose the controls completely where chains and sprockets are used, for if any small object should become wedged between two links of the chain it would tend to ride off the sprocket and jam against the chain guard. There is also a small inspection panel in the bottom of the fuselage under the stick. A small dentist's mirror is very useful when making this inspection.
2. Check for wear at both pivot points in the stick.
3. See that all chains are running smoothly over their sprockets with no tendency to ride off.

4 to 8 as for the Cirrus Hawk. 9 does not apply. 10 to 14 as for the Hawk Major.

15. Check the rudder bar pivot for wear on the Falcon VI, and examine the brake cable casings for damage.

16. Controls behind the rear spar can either be examined through two small holes provided in the rear seat, or by removing one seat.


A
B
C
D
E
F
G
H
I
CABIN
REAR DECKING
SCARF SPLICE 9:1 RATIO
EDGE OF PLY SHOWN EXAGGERATED
JOINT TO BE THOROUGHLY GLUED & CLAMPED TILL DRY
METHOD OF SCARF SPLICING PLY.
3
NEW PORTION OF SPRUCE DTD 36A SPLICED IN
¼" X Nº 4 C/SUNK BRASS WOODSCREWS A G S 250/11
¾ X Nº 4 C/SUNK BRASS WOODSCREWS A G S 260/19
JOINTS TO BE WELL GLUED & CLAMPED AS SHOWN
SPRUCE LAMINATIONS
METHOD OF REPAIRING DECKING FORMERS

NOTES

① ONLY FORMERS C,D,E,F,G&H MAY BE REPAIRED – ALL OTHER FORMERS & MEMBERS TO BE RENEWED IF DAMAGED.

② PLY PANELS MAY BE RENEWED BETWEEN ALL LETTERED FORMERS – IT IS IMPORTANT TO NOTE GRAIN MUST BE ATHWARTSHIPS

③ IN BAYS CD & DE SMALLER PANELS OF PLY MAY BE SCARF SPLICED IN – FOR EXAMPLE SEE SHADED PORTION DE.

④ CENTRE LINES OF SCARF SPLICES MUST BE ON THE CENTRE LINE OF A FORMER OR MEMBER IN ALL CASES

⑤ CELLON WINDSCREENS & PANELS MAY BE COMPLETELY RENEWED IF DAMAGED OR CRACKED.

⑥ AFTER SCARF SPLICING PLY IT IS ESSENTIAL THAT THE JOINT IS COVERED BY DOPING ON SERRATED EDGED 4OZ LINEN TAPE SPEC F1 OF SUITABLE WIDTH

Fig. 23.—STANDARD CABIN REPAIR SCHEMES.

17. Check for wear the aileron and rudder levers which are mounted on a common shaft behind the rear spar.

18. Check the cables where they pass through the seat bearers and fuselage sides respectively.

19. Check the trimming tab on the Falcon VI and take up any slackness that may develop in the system.

Fuselage and Tail Unit

1, 2, 3 and 7 as for the Cirrus Hawk, 4, 5 and 6 do not apply.

8. Examine the cabin door; this needs careful attention as it slides in shallow channels in the cabin frames. Should it become strained it will not slide easily and may tend to ride out.

9. Check the door hinges for tightness.

The remainder of the schedules are as for previous types.

WHITNEY STRAIGHT

Since this is a new type it is not possible to give a fuller schedule than that contained in the manufacturers' handbook.

1. Jack up the aeroplane until the undercarriage clears the ground and inspect in accordance with the "Airdraulic Bulletin." Special aluminium jacking pads are provided on the under surface of the centre section front spar, about 6 in. from the inboard side of the undercarriage fairing.

2. Remove all inspection covers and inspect the controls.

3. Inspect the trailing-edge flap gear. All flap bearings are fitted with self-lubricating bushes. It is advisable, however, occasionally to inspect these and apply a small quantity of thin lubricating oil.

Lubrication

Inspect the control column for free movement. Lubrication nipples are provided on the countershaft immediately behind the front spar. Access to these is easily obtained by raising the seat. Various working points at the base of the column, also the elevator-bias quadrant, should be lubricated occasionally with oil.

SUBSEQUENT INSPECTIONS

The twenty-five hour inspection is repeated, but in the event of a heavy landing or minor accident the following points require special attention :—

1. Inspect landing gear for local damage.
2. Inspect all parts of the airframe near the landing gear attachment fittings.
3. Inspect the centre section attachment to the fuselage.
4. Inspect the tyres.
5. Inspect the airframe for damage; should it have suffered any

serious damage the ply skin will be broken, in which case the aeroplane will be withdrawn from service for repair.

The annual inspection for Certificate of Airworthiness is too wide a subject to be dealt with in this article.

REPAIR SCHEMES

Repairs fall under two headings, minor repairs which can be made quickly and easily and major repairs which involve a considerable amount of work. The simple repairs are those which are covered by local patching of the structure. Should the ply covering, either on the wing or fuselage, suffer slight damage, it can be repaired by splicing in a new panel; this must be fitted with a 1 in 9 splice, which must be made along some solid part of the structure, *i.e.*, either ribs or struts. If a very small hole has been made it can be patched by cutting out the damaged portion neatly, inserting a ply stiffening ring, 1 in. wide, which must have at least ½ in. overlap on the structure, the other half taking a neat ply patch flush with the outer surface. The ring and patch are attached by glue and ¼ in. number 4 wood screws; in this way a practically invisible repair is effected.

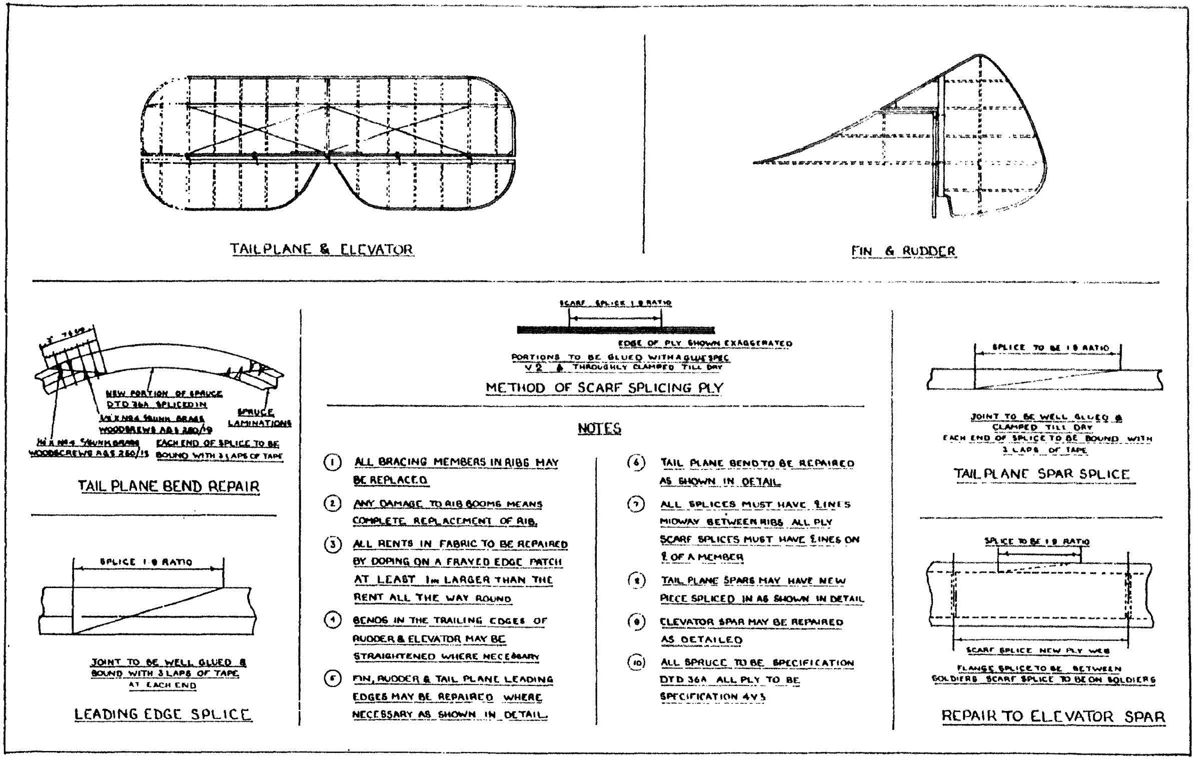
If a rudder or elevator bend is damaged it can be repaired as follows: open the bag at the trailing edge for the length of the required repair. Cut out the damaged portion of tube and bend up a new piece as a replacement. This is joined to the existing portion by inserting a dural or ash plug between the two and riveting it in place. The bag is then sewn up and re-taped and doped. Should a tail-plane bend be damaged it can be repaired by splicing a new portion of spruce in accordance with the drawing.

MAJOR REPAIRS

No major repair can be undertaken except to the approved drawings issued by the firm and under approved conditions.

Wings

Should a wing be damaged in such a way that there is no reason to suspect any alteration in the rigging dimensions, it can be repaired quite easily. Should the damage be more extensive, however, it will be necessary to set it up on the centre section to the correct dimensions. The datum lines are set on the spars inside the wings and the required dimensions are: incidence 1° 30′ at the root, washing out to 1° 20′ at "M" rib: dihedral 5° measured on the rear spar. Should a spar be damaged, new portions of flange or ply may be spliced in in accordance with the drawing. Damaged ribs must be replaced with approved spares. The ply skin can be made good as outlined under "minor repairs." Centre section spars can be repaired in the same manner and in addition there is a repair scheme to cover local damage at the undercarriage attachment points due to heavy landings.



TAILPLANE & ELEVATOR

FIN & RUDDER

TAIL PLANE BEND REPAIR

NEW PORTION OF SPRUCE DTD 36A SPLICED IN

3/4 X No4 SUNK BRASS WOODSCREWS A&S 280/19

1/2 X No4 SUNK BRASS WOODSCREWS A&S 280/15

EACH END OF SPLICE TO BE BOUND WITH 3 LAPS OF TAPE

SPRUCE LAMINATIONS

LEADING EDGE SPLICE

SPLICE 1:8 RATIO

JOINT TO BE WELL GLUED & BOUND WITH 3 LAPS OF TAPE AT EACH END

METHOD OF SCARF SPLICING PLY

SCARF SPLICE 1:8 RATIO

EDGE OF PLY SHOWN EXAGGERATED

PORTIONS TO BE GLUED WITH A GLUE SPEC V2 & THROUGHLY CLAMPED TILL DRY

TAILPLANE SPAR SPLICE

SPLICE TO BE 1:8 RATIO

JOINT TO BE WELL GLUED & CLAMPED TILL DRY
EACH END OF SPLICE TO BE BOUND WITH 3 LAPS OF TAPE

REPAIR TO ELEVATOR SPAR

SPLICE TO BE 1:8 RATIO

SCARF SPLICE NEW PLY WEB

FLANGE SPLICE TO BE BETWEEN SOLDIERS SCARF SPLICE TO BE ON SOLDIERS

NOTES

① ALL BRACING MEMBERS IN RIBS MAY BE REPLACED

② ANY DAMAGE TO RIB BOOMS MEANS COMPLETE REPLACEMENT OF RIB.

③ ALL RENTS IN FABRIC TO BE REPAIRED BY DOPING ON A FRAYED EDGE PATCH AT LEAST 1in LARGER THAN THE RENT ALL THE WAY ROUND

④ BENDS IN THE TRAILING EDGES OF RUDDER & ELEVATOR MAY BE STRAIGHTENED WHERE NECESSARY

⑤ FIN, RUDDER & TAIL PLANE LEADING EDGES MAY BE REPAIRED WHERE NECESSARY AS SHOWN IN DETAIL.

⑥ TAIL PLANE BENDS TO BE REPAIRED AS SHOWN IN DETAIL

⑦ ALL SPLICES MUST HAVE ℄INES MIDWAY BETWEEN RIBS ALL PLY SCARF SPLICES MUST HAVE ℄INES ON ℄ OF A MEMBER

⑧ TAIL PLANE SPARS MAY HAVE NEW PIECE SPLICED IN AS SHOWN IN DETAIL

⑨ ELEVATOR SPAR MAY BE REPAIRED AS DETAILED

⑩ ALL SPRUCE TO BE SPECIFICATION DTD 36A ALL PLY TO BE SPECIFICATION 4V3

Fig. 24.—STANDARD TAIL UNIT REPAIRS.

Fuselage

The longerons can be repaired by splicing in a new section. The splices must fall in the centre of a bay between struts, the standard 1 in 9 splice must be used, glued and screwed as shown on the drawing. Damaged struts must be replaced. Ply can be repaired by scarfing in a new panel on the centre line of the struts.

Tail Unit

The rudder and elevator box spar are repaired in the same manner as the wing spars, care being taken to see that the splices fall between the soldiers. The tail plane spars and leading edge may be similarly spliced. If damage to a rib is slight the member may be replaced, but if a rib boom is damaged a new rib is required. Standard fabric repairs should be employed ; if there is a large rent in the top surface of a fabric-covered component, a neater repair than the standard square patch can be made by sewing in a new panel in such a way that the stitching is covered by the tapes over the ribs.

Fittings and Tanks

Damaged fittings must be replaced. In certain cases worn holes may be re-bushed, but for all information on this question the makers should be consulted.

Should it be required to remove a fuel tank for repair, the following procedure should be adopted :—

1. Drain all fuel from the tank, making sure that the cock is in the " all-off " position.
2. Disconnect the fuel pipe and remove the sump, filler neck, fuel gauge ring and vent pipe. These are all attached by bolts to rings riveted to the inside of the tank, fuel tight joints being effected by washers.
3. Remove the wing folding check cable, and the two tank stops.
4. Withdraw the tank from the centre section.

To remove the oil tank from the leading edge :—

1. Drain the tank.
2. Disconnect the two oil pipes and the vent pipe inside the fuselage.
3. Lift up the portion of the wing root fairing which covers the tank.
4. Unfasten the three bolts at the top and at the bottom of the tank and remove it from the centre section.

The majority of oil tanks are of tinned steel, but the Whitney Straight has a quickly detachable aluminium oil tank on the fireproof bulkhead. Early fuel tanks are of tinned steel, and recent ones of aluminium ; repairs to these can only be undertaken by expert labour under approved conditions.

The whole question of repair schemes is very wide, and should cases arise which are not covered by the normal repair schemes supplied in the instruction manual, it is essential to apply to the makers for instructions.

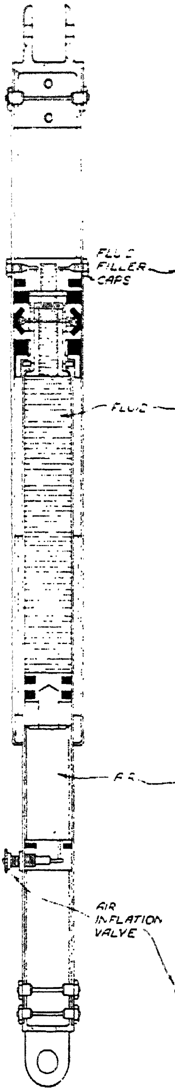


Fig. 25.—STRUT FULLY COMPRESSED.

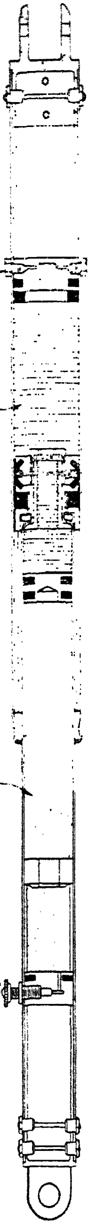


Fig. 26.—STRUT FULLY EXTENDED.

"AIRDRAULIC" SHOCK ABSORBER STRUT

EXAMPLES OF POSSIBLE FAULTS, REASONS AND REMEDIES

1. Lower telescopic tube is extended but does not move, or only moves a small amount when taxi-ing.	*Reason :* Air pressure too high or too much fluid in strut. *Remedy :* Correct air pressure or fluid level.
2. Lower telescopic tube does not extend to normal position and aeroplane wallows on a turn.	*Reason :* Air pressure or fluid level too low. *Remedy :* Correct air pressure or fluid level.
3. Lower telescopic tube will not extend when air pressure is correct.	*Reason :* No fluid in strut. *Remedy :* Recharge strut and test for fluid leaks.
4. Lower telescopic tube extends normally and air pressure is correct, but aeroplane wallows badly on a turn.	*Reason :* Fluid level too low. *Remedy :* Correct fluid level.
5. Lower telescopic tube is at normal extension and air pressure correct, but aeroplane very harsh when taxi-ing.	*Reason :* Fluid level too high. *Remedy :* Correct fluid level.
6. Loss of fluid from upper telescopic tube.	*Reason :* Glands damaged by use of incorrect fluid, or tube scored. *Remedy :* Dismantle strut and replace gland rings.
7. Loss of air pressure from lower telescopic tube.	*Remedy :* Ascertain that valves are tight. If leaks still maintain, detach the unit and submerge completely in water to locate the fault.

SERVICE NOTES FOR THE "AIRDRAULIC" SHOCK ABSORBER STRUT

Daily Inspection

Observe aeroplane from front when at rest on level ground. If wings show a list to either side it may be due to some fault in the " AIRDRAULIC " STRUT on the side to which the list occurs, or particularly in the case of the full cantilever type, to excessive friction in the moving parts of the strut. Rock aeroplane when, if excessive friction is the cause, it will probably right itself. If not proceed as follows :—

(*a*) Examine strut for any unusual seepage of fluid. If this is evident carry out operations 1, 2, 3, 4 and 5 below.

If there appears to be no fluid leak :—

(*b*) Inflate as described in operations 6 and 7 below. Special tables will be provided on request, to obviate the necessity for jacking up during inflation.

If the aeroplane rests on an even keel examine lower telescopic tube of strut (or fairing) to verify there is not more than half the available travel taken up by the weight of the aeroplane. The full travel position will be indicated by the polished surface of the strut tube (or fairing). In the event of re-charging being necessary proceed as in paragraphs (*a*) and (*b*) above.

Re-charging Instructions

1. With full weight of aeroplane on wheels deflate strut by depressing air valve needle. It is MOST IMPORTANT that strut is FULLY COMPRESSED, as shown in Fig. 25, before filling with fluid.

2. Remove one of the two fluid plugs indicated in Fig. 25 and insert in its place the nozzle of the fluid gun specially provided for this purpose.

Caution.—Only special AIRDRAULIC FLUID must be used in the gun and the strut. When filling the gun operate very slowly to avoid sucking in air.

3. Keep the air valve needle depressed by reversing the valve cap and force fluid from the gun until no more will enter.

4. Remove second fluid plug indicated in Fig. 25 and continue gently to force fluid from the gun until a clear stream, *i.e.*, free from air bubbles, emerges from the orifice.

5. Replace both fluid plugs and firmly screw home. Care should be taken not to damage the hard fibre washers on which the plugs seat to form a seal.

6. Jack up the aeroplane until the wheel is sufficiently clear of the ground to allow the strut to assume the FULLY EXTENDED position, as shown in Fig. 26, when inflated.

7. Inflate with special air pump provided until the correct pressure shown on the name plate of the strut is reached, allowing the strut to extend fully. Make sure wheel is clear of ground and strut in fully extended position on reaching correct pressure.

8. Remove air pump from valve and examine strut for air or fluid leaks.

9. Replace fluid plug locking wires, air valve cap, and remove jack when strut will be ready for use.

A Few Don'ts

DON'T remove any part of the Strut until all air pressure has been released. To do so would be dangerous to the mechanic.

DON'T fill with fluid unless the Strut is FULLY COMPRESSED as Fig. 25, otherwise it will not function correctly.

DON'T inflate unless the Strut can EXTEND FULLY as Fig. 26, otherwise it will not function correctly.

DON'T use any other than genuine " AIRDRAULIC " FLUID, otherwise the component parts of the Strut may be damaged.

DON'T carry out any maintenance work without reference to the preceding instructions.

THE DE HAVILLAND VARIABLE-PITCH AIRSCREW

NOTES ON CARE AND MAINTENANCE

THE routine maintenance of the airscrew will vary to some extent with the type of installation and conditions under which it is operated, but in every case a schedule should be adopted to ensure that the airscrew receives regular attention and that

(*a*) it remains tight upon the airscrew shaft;
(*b*) the piston leathers are securely held;
(*c*) it is adequately lubricated;
(*d*) the fastenings and locking arrangements remain unimpaired;
(*e*) the rate of wear and tear of the moving parts is proceeding normally; and
(*f*) that no damage to blades from impact with stones or cinders, etc., picked up from loose aerodrome surfaces escapes attention.

Check for Tightness on Shaft

It is recommended that all controllable-pitch airscrews be checked for tightness on the engine shaft after the first flight following installation, for which purpose it is necessary to remove the cylinder head of the de Havilland airscrew and withdraw the split pins which secure the piston locking-ring to the lip of the spider.

The piston wrench and tommy bar are then assembled in the piston and checked up; if any movement occurs, the piston must be put up very firmly, until the split pins can again be entered.

On airscrews absorbing 800–1,000 h.p., the torque required is about 800 lb.-ft., and usually it will be found more convenient to carry out this check by beating up the tommy bar whilst it is under load; it should not, however, be carried out whilst the engine is hot.

In the case of airscrews mounted upon a parallel spline, it should not be necessary to repeat this check, but where the taper spline is employed it is recommended that the airscrew be again checked for tightness after ten hours flying or as soon afterwards as operational requirements permit.

Check Piston Leathers

It is convenient to check the nut holding the piston leathers on these occasions, as in the normal course of operation these become suffused with oil and more pliable, and may permit leakage of oil behind their seatings—to appear and be flung off from the drain holes at the base of the cylinder—or even permit the inner leather to be pulled over its seating, so destroying the oil seal.

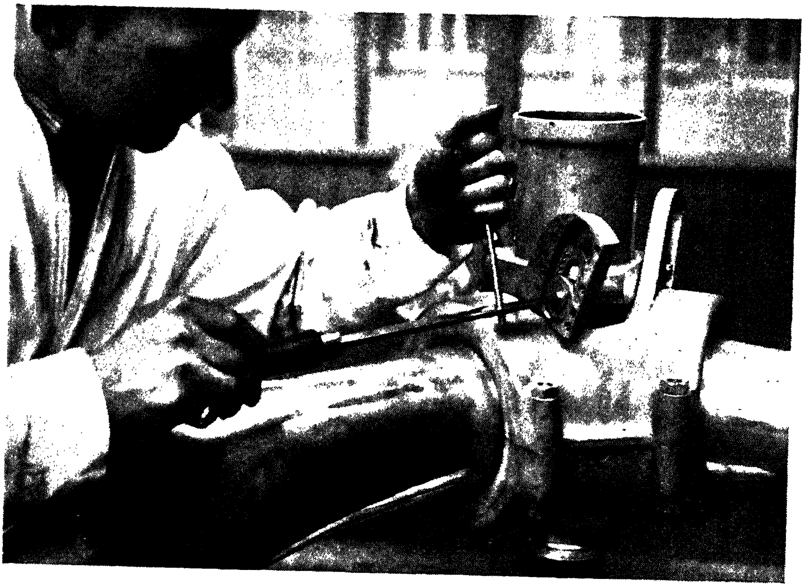


Fig. 1.—Removing counterweight bearing shafts.

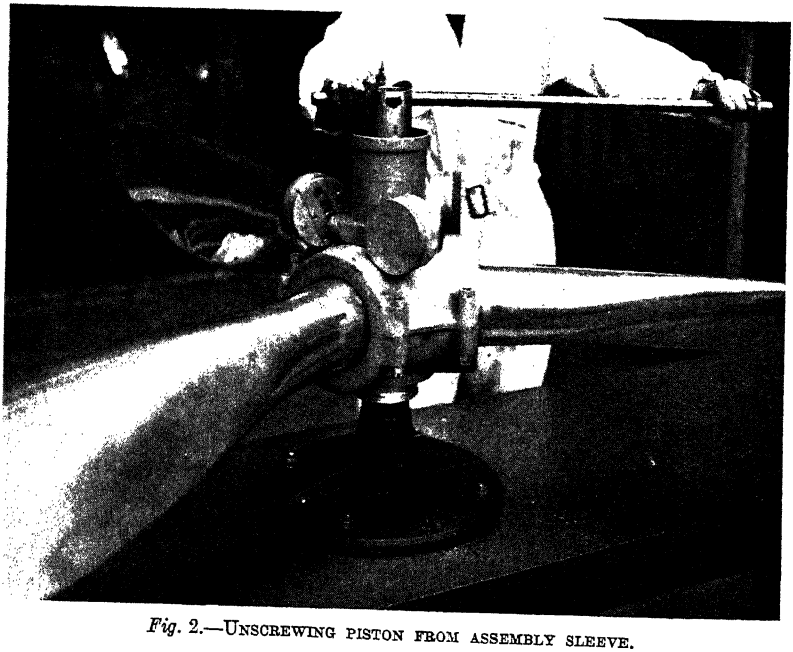


Fig. 2.—Unscrewing piston from assembly sleeve.

The nut should be put up firmly, but care must be taken not to overtighten, which might result in dragging or splitting the leathers.

Periodical Lubrication

Lubrication is effected by forcing grease into the hub through the nipples by means of a special grease gun and charging the counterweights by means of a small flat implement through the slot in which works the counterweight bearing-shaft at the rear. This attention is recommended at intervals not exceeding ten hours flying, as greasing is more important from the point of view of preventing corrosion of the working parts, than from that of promoting their free movement, and as a considerable proportion is thrown off by centrifugal force, it is desirable to carry out this operation as often as circumstances permit.

No serious difficulties need be anticipated if operational requirements or inaccessibility of the airscrews call for an extension of this period, but wear and tear must be expected to increase. The rate of increase will also be in relation to the sand or dust encountered in flight or on the aerodrome, sea air and spray, rain, fog and exposure to the elements in general.

The question of lubrication must, therefore, be considered along broad lines in order to determine a compromise which will afford the most frequent attention compatible with operational requirements or convenience.

The locking arrangements of the airscrew should be certified in the daily inspection report.

Wear and tear of the airscrew components—as distinct from fracture and distortion—may be expected to proceed at a steady rate, which, however, as pointed out above, will vary with the frequency of routine attention and the general conditions under which the airscrews are run.

Routine Inspection

Routine inspection should be carried out with the object of noting the rate of wear and tear and the detection in the early stages of any abnormal condition which might possibly become a source of trouble or danger. Any component regarding the continued serviceability of which there is any doubt should be changed.

Damage to metal blades can occur by abrasion due to the impact of stones, etc., drawn up from the surface of the aerodrome by the vortex action of the airscrew, or be inflicted accidentally by dropped tools, etc., or it can be the result of erosion by sand, dust, rain or hail, or corrosion by sea water.

In all cases, however, it is desirable that any damage should be removed at the first opportunity by careful scraping or filing and polishing.

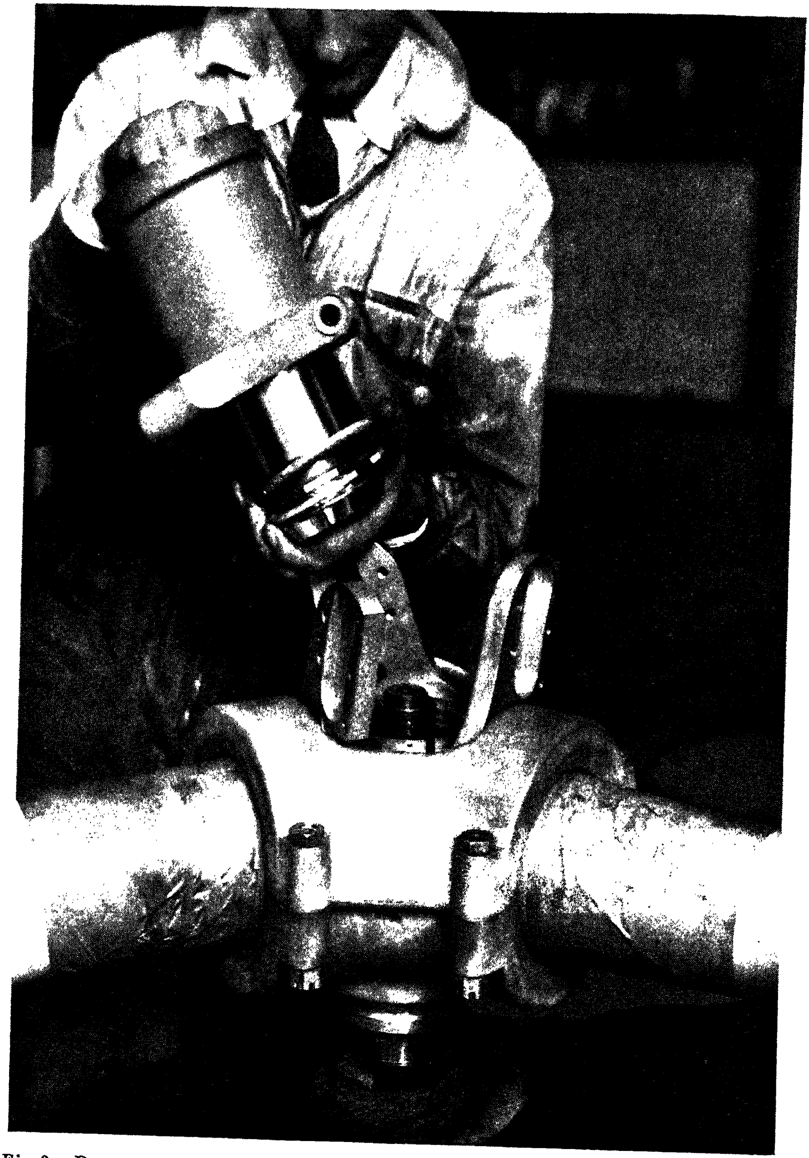


Fig. 3.—REMOVING CYLINDER, PISTON, PISTON LOCKING RING, SNAP RING AND FRONT CONE FROM AIRSCREW.

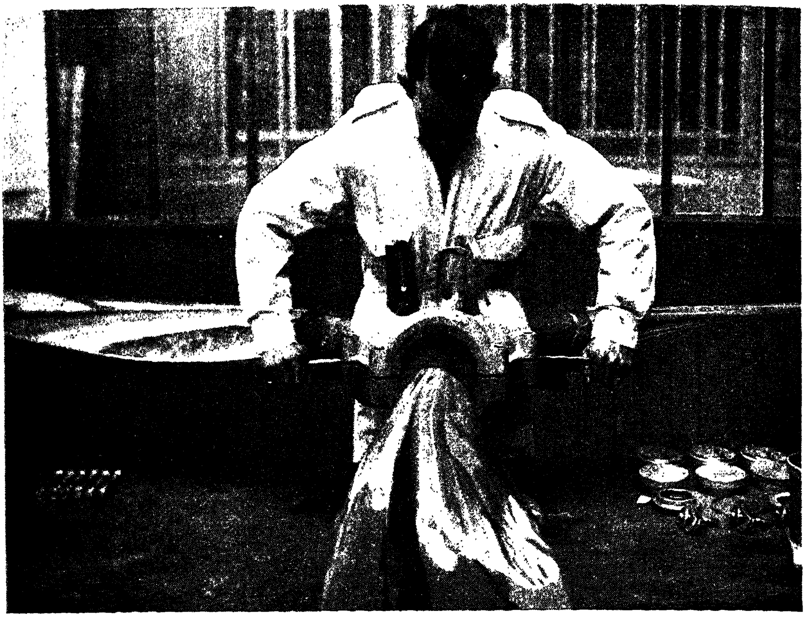


Fig. 4.—REMOVING TOP HALF OF BARREL.

Removal from Airscrew Shaft

To dismount the airscrew, it is necessary first to remove the cylinder cover and to withdraw the split pins securing the piston locking-ring to the lip of the spider, when unscrewing the piston will withdraw the airscrew from the taper.

A sling is then made fast round two of the blade roots and the weight is taken by means of tackle, when the airscrew may be drawn off the shaft and lowered.

To re-install the airscrew these operations are reversed with the addition that before mounting the airscrew, the splines of the engine shaft should be smeared with anti-seizing compound recommended by the engine makers.

Dismantling and Re-assembly

For the purpose of checking blade angles, balance and the various fits and clearances which are controlled by the relative positions of the spider and piston, it is necessary to provide a mandrel which is a replica of the engine shaft on which the airscrew can be assembled.

This splined sleeve, as it is called, is bored to accommodate the balancing mandrel, which is a straight ground bar, and which in turn, fits perpendicularly into a base plate. This last can be mounted on any bench for the purpose of stripping and re-assembling the airscrew, but

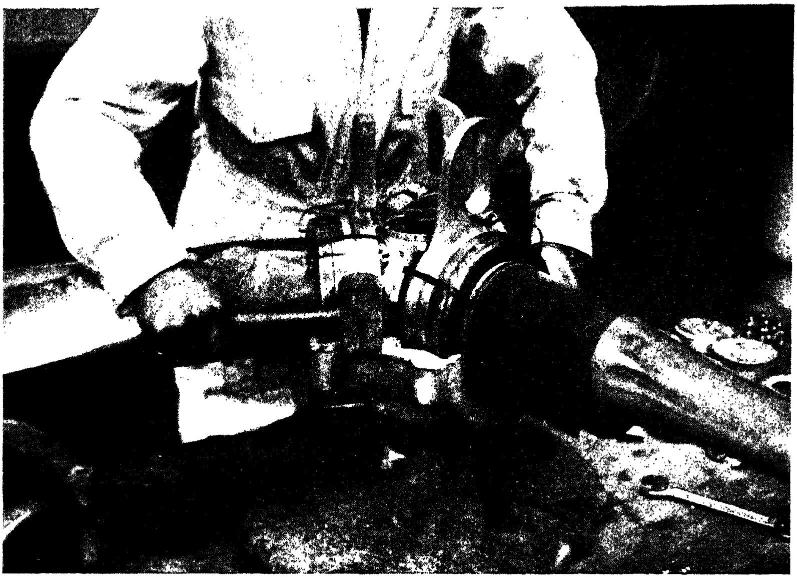


Fig. 5.—LOWERING BOTTOM HALF OF BARREL.

for checking blade angles, it requires to be fitted on a surface table, which, it is desirable, should be marked out with lines scribed at right-angles to a centre line at distances of 30 and 42 in. from the centre of the airscrew hub.

Order of Dismantling

The airscrew is lowered on to these assembled mandrels, and the cylinder cover with its locking ring having already been removed, the order of dismantling is given below :—

(*a*) Extract split pins and locking pins and unscrew counterweight caps. Check and record the blade settings indicated on the lead fillings in the counterweight and remove adjusting-screw assemblies.
(*b*) Remove the screws holding counterweights to brackets, and tap the counterweights off.
(*c*) Remove counterweight bearing-shaft split pins from cylinder.
(*d*) Unscrew counterweight bearing-shafts and remove shafts and bearings as units.
(*e*) Disengage spider snap-ring by inserting two screwdrivers in grooves provided and compressing snap ring.
(*f*) Lift cylinder, piston, snap ring, cone and lock ring as a unit.
(*g*) Remove barrel bolts.

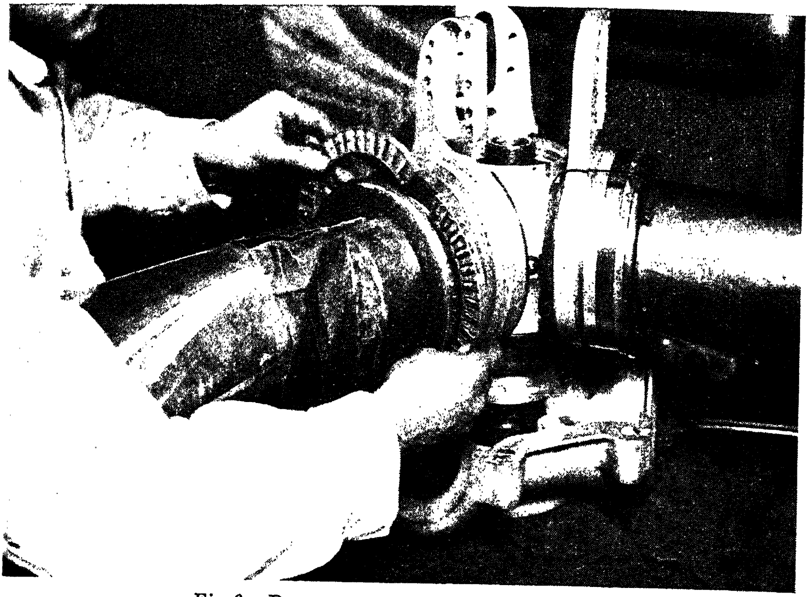


Fig. 6.—REMOVING THRUST BEARING CAGES.

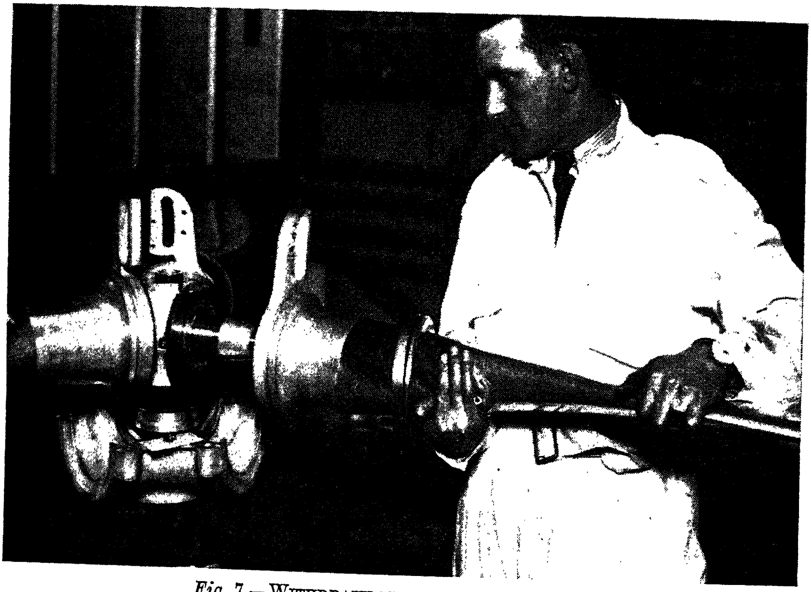


Fig. 7.—WITHDRAWING BLADE FROM SPIDER.

Note greasing nipple removed.

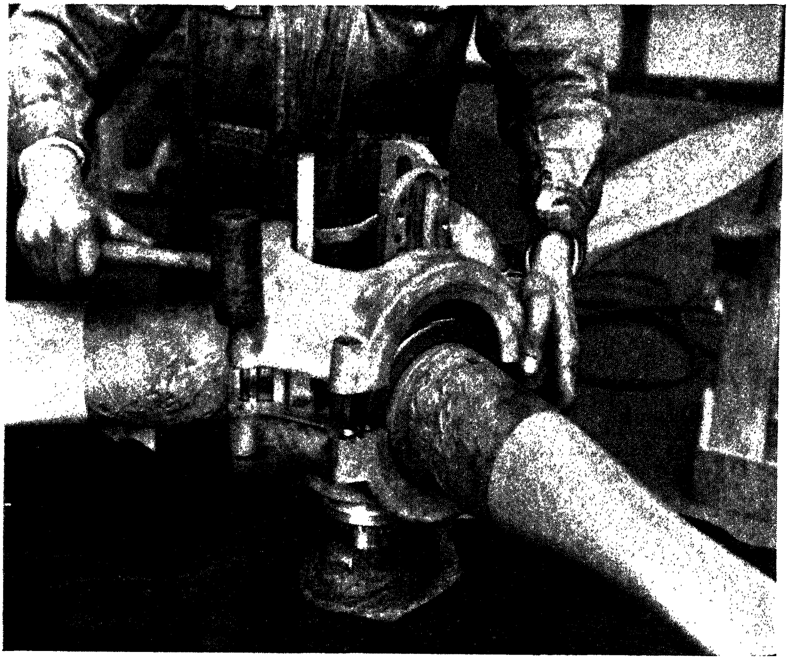


Fig. 8.—ASSEMBLING FRONT HALF BARREL.

(*h*) Wrap blade shanks to prevent chafing by the thrust bearings during and after removal from the barrel.

(*i*) Separate the halves of the barrel by using a lever in the slots provided in the joint face on the rear half, thus lifting the top and lowering the bottom.

(*j*) Check to be sure that blades and bearing races are marked so that they may be re-assembled in their proper positions.

(*k*) Pull blades from spider. In no circumstances should the blades be prised at the shank to aid removal. Care must be taken when withdrawing blades from spider and when removing counterweight brackets from blade bushings that the index pins do not drop out.

(*l*) Note location of index pins on the counterweight bracket, so that the airscrew may be re-assembled with the same base setting.

(*m*) Remove shimplates from spider.

(*n*) Remove barrel chafing ring.

(*o*) Remove spider from mandrel.

Greasing and Re-assembly

The various components must be freed from grease and cleaned for inspection.

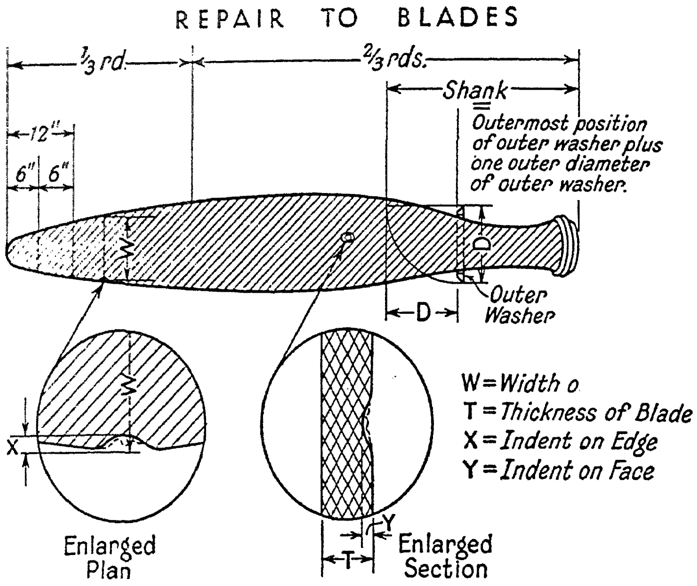


Fig. 9.—REPAIR TO BLADES. (See also page 245.)

This order of dismantling is reversed for re-assembly in the ungreased condition for balancing after overhaul, but in final assembly it is necessary to charge the bores of the blades and spider arms with grease in order to ensure that no air is imprisoned in the hub, which, by excluding grease, might upset the balance of the airscrew and give rise to vibration in flight.

Grease is poured into each blade bore to a level within 2 in. of the face of the blade ends, which are then placed in position on the spider arms and pressed into position.

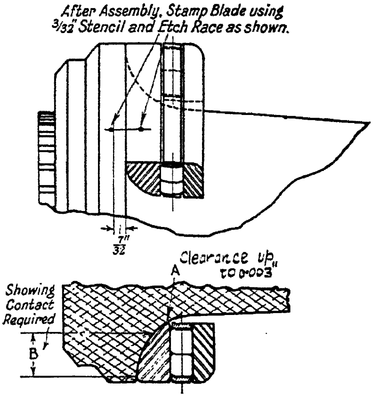

After Assembly, Stamp Blade using 3/32" Stencil and Etch Race as shown.
7/32"
Clearance up to 0·003"
A
Showing Contact Required
B

Fig. 10.—FITTING OF THRUST RACE BEARING.

A non-return valve is incorporated in the greaser nipple, and it is necessary, therefore, to remove this nipple to permit the egress of air and surplus grease. Care should be taken, however, to replace the nipples before the bottom half of the barrel is drawn up over the blade ends, as they cannot be fitted with the barrel in position.

Inspection of Parts

Inspection of airscrew components is carried out for the purpose of detecting fractured or otherwise unservice-

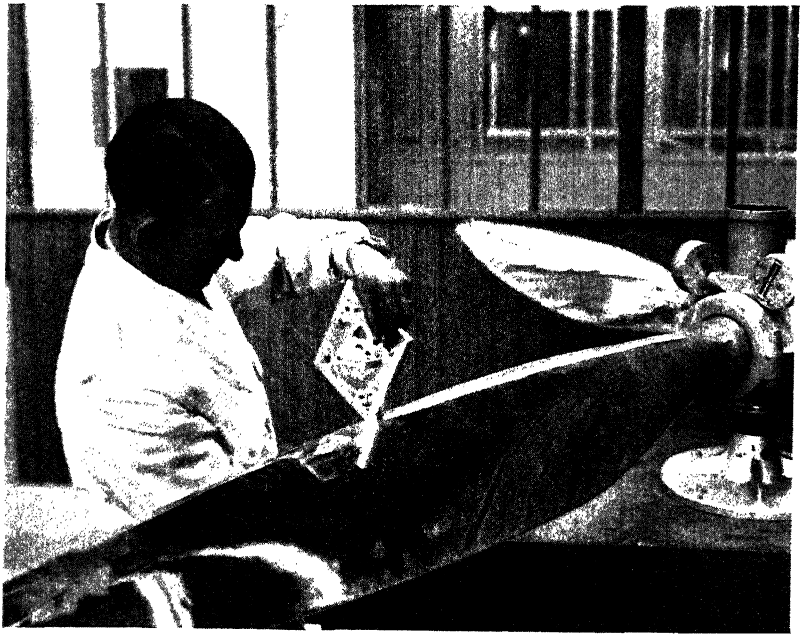


Fig. 11.—CHECKING BLADE ANGLES WITHOUT SURFACE TABLE.

able parts, assessing the wear and estimating the further useful life of those parts which still are serviceable and for specifying the detail of repairs or attention which are required to make good the effects of wear and tear.

Examine for Cracks

In such a highly stressed unit the inspection must be carried out with meticulous care and a close attention to detail—all ferrous components should be tested for cracks or imperfections on a magnetic type of detector and blades should be examined under a powerful magnifying glass.

And Abrasions

Abrasions on the blades should be scraped out and converted into smooth rounded depressions, whilst damage to the edges or tips should be smoothed off or, where they take the form of sharp nicks or jags, they must be blended out to a smooth contour.

The object in each case is to convert any damage to the blade which amounts to an abrupt change of section, into a gradual change in order to avoid the concentration of stress at that section.

Wear, Plucking and Chafing

In addition to the usual evidences of wear and tear, *e.g.*, ovality and wear of blade bushes, cylinder bore, spider arms, etc., the airscrew invari-

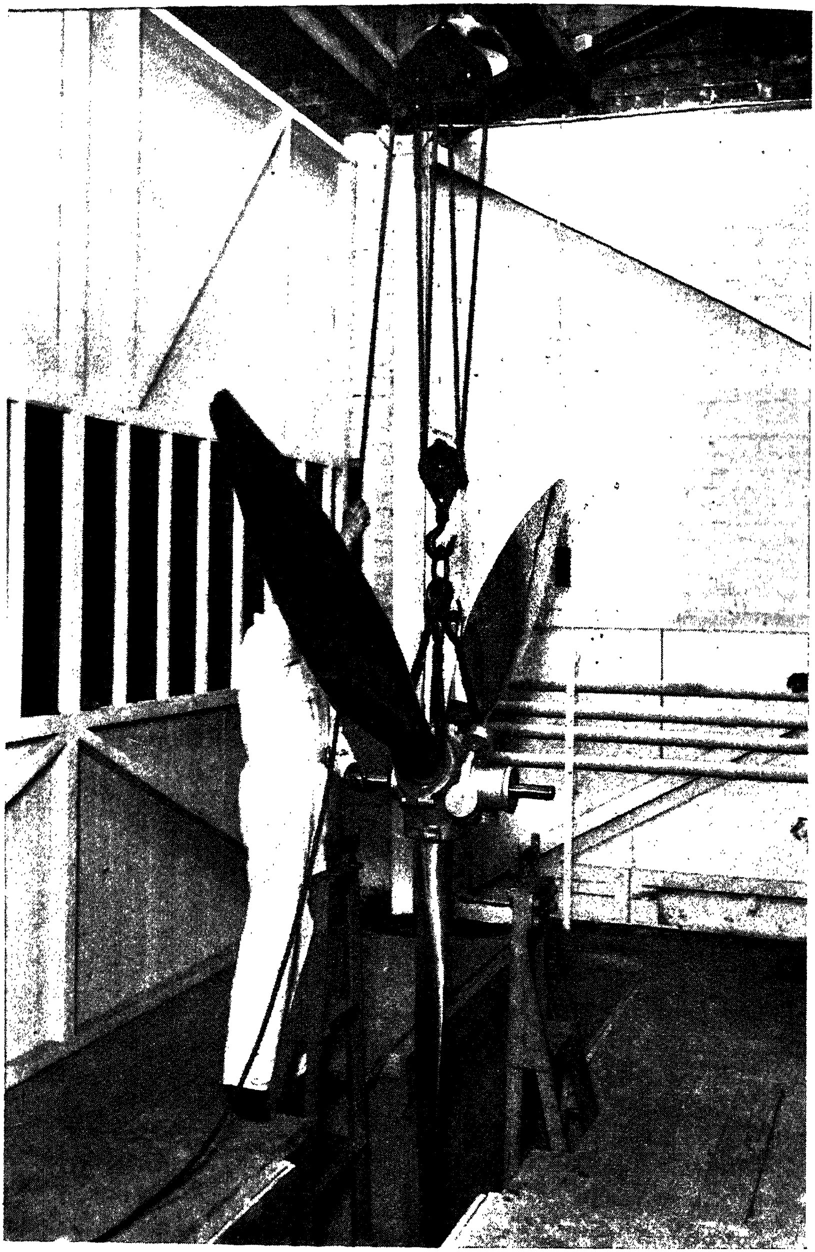


Fig. 12.—LOWERING AIRSCREW ON BALANCING WAYS.

COMPARATIVE SIZES OF DE HAVILLAND AND HAMILTON STANDARD CONTROLLABLE-PITCH AIRSCREWS

American shank .	A	B	C	D	D	E	F
British size . .	1000	2000	3000	4000	4000	5000	6000
No. of blades .	2	2	3	2	3	3	3
Approximate horse power absorbed .	200	350	500	500	700	900	upwards

BALANCING TABLE

Shank Size.	No. of blades.	*Dimension.* Distance from centre of hub to outboard face of balancing washers. (L) (see Fig. 13).
1000	2	7·01″
2000	2	8·16″
3000	3	8·87″
4000	2	9·89″
4000	3	10·23″
5000	3	11·84″

ably presents some appearance of "plucking," chafing or scoring on some of its hub parts, whilst after considerable running time the roller and ball races tend to become "brinelled" and pitted.

These effects may almost be said to be characteristic of the airscrew and result from the very severe and fluctuating loads to which it is subjected and to the corrosive action of the elements.

They do not, however, impair either the safety or the serviceability of the airscrew and the affected parts only require to be smoothed over with oilstone at intervals during their effective life.

Repair Tolerances

A schedule of tolerances and clearances will be found at the end of this article.

Re-assembly and Balance

Prior to re-assembly any new parts which have been fitted must be marked with the same identification number as the parts discarded, and all parts should be lightly greased. The airscrew is then assembled in

SHANK SIZE	BALANCING MOMENT OZ.-INS.
1000	19
2000	23
3000	25
4000	29
5000	34

Note: *The balancing moments are the values obtained with 12 washers. Size AGS. 160/H.*

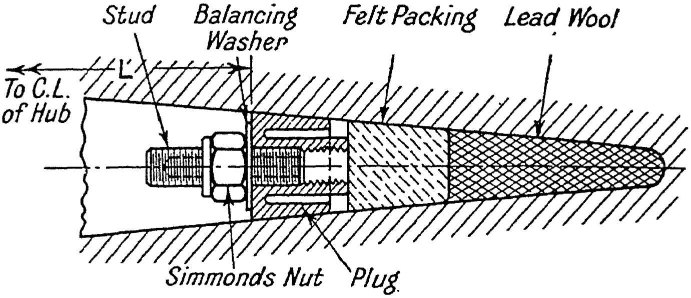


Fig. 13.—BALANCING.

1. This balancing plug assembly is the same for 4000 and 5000 type airscrews.
2. It replaces the old system of fixed plugs and corks.
3. For servicing and repairing blades. Variations in balance up to the amount shown may be obtained by adding up to 12 AGS. 160/H washers.
4. Finer degrees of adjustment may be obtained by mixing AGS. 160/H and AGS. 160/I washers.

the reverse order to that detailed on p. 227, commencing first by placing the rear half of the barrel over the sleeve mounted on the assembly table, then placing the spider in position, etc., care being exercised that all the assembling numbers—1 and 2 or 1, 2 and 3 in the case of a three-way airscrew—match up.

When completely assembled, the piston is screwed hard up on the sleeve—in the manner detailed for securing it upon the engine shaft—which then becomes firmly fixed and is accurately centred in the airscrew hub.

Trial Check of Blade Angles

At this stage a trial check of blade angles should be carried out to prove correct assembly by measuring at the appropriate station the angle between the face of the blade and the surface of the assembly table, using an adjustable protractor.

Balancing

The airscrew is then lifted off the assembling mandrel and placed on the balancing ways supported by the balancing mandrel which is a bar of

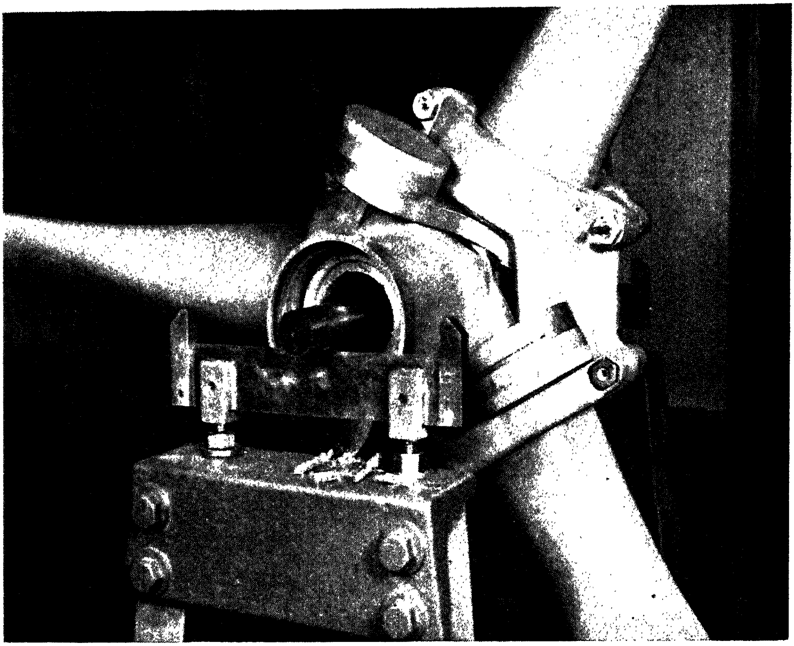


Fig. 14.—CLOSE-UP VIEW OF 5000 SIZE THREE-BLADE AIRSCREW ON THE KNIFE EDGES.

Showing the application of leadwool in the hollow barrel bolts. These bores are finally closed with sealing caps. Balancing is carried out in a draught-proof cubicle.

specially toughened steel designed to support the weight of the airscrew without flexing, and which is passed through the bore of the assembling sleeve.

It is desirable that the balancing ways be screened from draughts, and simple knife edges, each mounted upon a strong metal tower, are preferable to ball-bearing mounted mandrels or wall-mounted cantilever type fixtures because of the considerable weight of the larger types of airscrew.

All component parts are balanced individually against a master in the course of manufacture and checked within a very minute tolerance for weight. They are therefore interchangeable both as regards dimensions and moment. Owing, however, to the cumulations of the tolerances on the dimensions of the various parts—adjusted by shimplate—and to the algebraic sum of the similar margins on moment and weight, it is usual to find, at this stage, some want of balance and the airscrew will usually take up one position to which it will return if moved from rest.

In the case of a flywheel or disc, such an error could be cancelled out by adding or subtracting a single correcting moment at the rim, but in the case of an airscrew it is only possible or permissible to apply this correcting moment along the lines passing through the centres of the blades—the adjustable blade plug—or along the lines passing through the centres of the barrel bolts—whose bores can be weighted with lead—and the axis of rotation.

Unless, therefore, the " out of balance " vector lies accurately along one of these lines, it is difficult to attain a condition of perfect balance.

It is not difficult, however, to obtain balance within such a sufficiently small margin that no question of setting up vibration arises, and this is effected by balancing each blade in turn in both the horizontal and vertical positions.

Horizontal Balance

Horizontal balance is obtained by trying each blade in turn in both the horizontal positions and correcting any disposition to move by suspending—or preferably tying with thread—adjustment washers on the shank of the blade at the position they will occupy eventually on the blade plug.

Minor adjustments to horizontal balance may also be made by varying the amount of lead in the barrel bolts, but it is desirable in this case to add to or remove the same amount of lead from each bolt, either side of the blade, whose moment is being adjusted.

It is possible by these means to get perfect horizontal balance on each blade without difficulty and indeed no tolerance on horizontal balance is permitted.

Edge Balance

The blades are then turned into the vertical position, and without making any adjustments, each is noted whether it tends to remain stationary or to fall away from the vertical in the direction of the leading edge, when it is known as leading edge heavy, or towards the trailing edge—trailing edge heavy.

Careful consideration must be given to the method of correcting any want of edge balance, for whilst no difficulty occurs in moving the effective centre of gravity towards or from the centre when the blade is in the horizontal position, it is required for edge balance to move the centre of gravity across the blade, and the only available means is by altering the lead content of the barrel bolts to produce a couple tending to turn the airscrew in the opposite direction to that in which it is disposed to move.

As any disturbance of the lead in the barrel bolts, however, will probably upset the horizontal balance, it is essential to make the least possible alteration and a tolerance of 3 in.-oz. therefore is permitted, which usually is applied by resting an ounce weight on that face of the barrel aperture which is following the movement of the blade from the vertical.

This will almost always effect a balance, but where further adjustment is required, it should be provided by removing a little lead from that barrel bolt farthest removed from the centre of rotation on the heavy side, and adding it to the bolt similarly placed on the light side and re-adjusting the horizontal balance—if necessary—by the first method.

When balance is obtained, the airscrew must be stripped, and all the added moments must be assembled on the blade plugs or tamped into the bores of the bolts, when if the corrections required have been considerable, it is desirable again to assemble the airscrew and check balance dry.

Wet and Dry Balance

If, however, the static balance is satisfactory dry, the airscrew is dismantled and re-assembled charged with grease as described in a previous paragraph, and as an additional precaution, grease is forced in through the nipples until the hub is palpably full, and in this state it is desirable that the airscrew be again balanced " wet " as a check that the grease is evenly distributed within the hub.

SCHEDULE OF FITS, CLEARANCES AND REPAIR TOLERANCES FOR DE HAVILLAND VARIABLE-PITCH AIRSCREWS

TYPES 4/1, 5/1, 5/2 and 5/3

1. The data regarding fits and clearances are specified under four headings, *i.e.*, " Dimensions, new," " Permissible worn dimension," " Clearance, new," and " Permissible worn clearance."

2. All dimensions are given in inches and decimals of an inch, together with a fractional suffix. The fractional suffix represents that fraction of a thousandth of an inch by which the actual dimension exceeds the decimal figure quoted. Thus a dimension given as $0{\cdot}531\frac{2}{10}$ in. when written in full would be 0·5312 in.

3. The figures in the column " Dimensions, new," are the drawing sizes to which parts are made. These dimensions are given in limit form and represent the minimum and maximum sizes to which parts may be accepted when new, as, for example, $\dfrac{0{\cdot}531\frac{2}{10}}{0{\cdot}531\frac{7}{10}}$ quoted for bearing shaft bushing bore.

4. The difference between the minimum and maximum dimensions quoted in paragraph 3 is known as the manufacturing tolerance. This tolerance is necessary as an aid to manufacture and its numerical value is an expression of the accuracy required by the design ; it may also be considered as a numerical expression of the desired quality of workmanship. For the bearing shaft example referred to in paragraph 3, the tolerance is $0{\cdot}000\frac{1}{2}$ in.

5. The dimensions in the column " Permissible worn dimension " represent the limits of size to which parts may be worn and refitted for a further period of service.

Note.—These dimensions have been so fixed that the components are fit for the full period of further service, which is normally permitted between complete overhauls. When, however, parts are found, during complete overhaul, to be worn beyond the limits laid down, they must be discarded as unserviceable.

6. In the column "Clearance, new," are given the minimum and maximum working clearances obtainable with new parts when assembled together; these are functions of the minimum and maximum sizes of mating parts given in the "Dimensions, new" column. For example, if a new bearing shaft machined to the minimum diameter $0{\cdot}530\frac{2}{10}$ in. is assembled with a new bearing shaft bushing, having a bore machined to the maximum size, $0{\cdot}531\frac{7}{10}$ in., the resulting working clearance will be $0{\cdot}001\frac{1}{2}$ in. L; similarly, if a new bearing shaft machined to its maximum diameter $0{\cdot}530\frac{7}{10}$ in., is assembled with a new bearing shaft bushing machined to the minimum size, $0{\cdot}531\frac{2}{10}$ in., the resulting working clearance will be $0{\cdot}000\frac{1}{2}$ in. L.

Note.—Under the columns "Clearance, new" and "Permissible worn clearance" the suffices L and T represent Loose and Tight respectively.

7. The "Permissible worn clearance" is the limit of working clearance permissible between any two parts assembled together.

8. If a male member, worn to the minimum diameter, is assembled with a corresponding new female part, machined to the minimum drawing dimension, the resulting working clearance between the two parts will, in most cases, correspond with the maximum permissible worn clearance. Similarly, if a female part, worn to the maximum permissible bore diameter, is assembled with a corresponding male part, machined to the maximum drawing dimension, the resultant clearance will be the same. For example :—

New bearing shaft bush having bore to minimum drawing limit	$0{\cdot}531\frac{2}{10}$ in.
Bearing shaft worn to permissible diameter	$0{\cdot}528\frac{7}{10}$ in.
Resultant clearance	$0{\cdot}002\frac{1}{2}$ in. L.

Bearing shaft bush worn to maximum bore diameter, *i.e.*, permissible size	$0{\cdot}533\frac{2}{10}$ in.
Bearing shaft having a diameter to maximum drawing dimension	$0{\cdot}530\frac{7}{10}$ in.
Resultant clearance	$0{\cdot}002\frac{1}{2}$ in. L.

9. On page 242 will be found three diagrams which are intended to facilitate reference to the various points at which wear occurs. All points of wear in each assembly are shown in the appropriate

GENERAL ASSEMBLY—*continued*

SECTION.

FIG. 15.

Diagram reference No.	V.P. airscrew type.	Parts and description.	Dimensions, new.	Permissible worn dimension.	Clearance, new.	Permissible worn clearance.	Remarks.
3	4/1, 5/1, 5/2 & 5/3	Shim plate bore . .	4·250″ / 4·252″	4·258″			
		SPIDER SPIGOT IN SHIM PLATE BORE.			0·005″ L / 0·009″ L	0·013″ L	
		Spider spigot diameter .	4·243″ / 4·245″	4·237″			
4	4/1	Barrel bore . . .	4·812½″ / 4·813½″	4·843″			
		Barrel chafing ring diameter.	4·807″ / 4·812″	4·781½″	0·000½″ L / 0·006½″ L	0·031″ L	
	5/1, 5/2 & 5/3	BARREL CHAFING RING IN BARREL.					
		Barrel bore . . .	5·500″ / 5·501″	5·531″			
		Barrel chafing ring diameter.	5·495″ / 5·500″	5·469″	0·000″ / 0·006″ L		
5	4/1	Barrel bore . . .	6·750″ / 6·755″	6·762″			
		Shim plate and shim plate chafing ring diameter.	6·750″ / 6·752″	6·740″			
	5/1, 5/2 & 5/3	SHIM PLATE AND SHIM PLATE CHAFING RING IN BARREL.			0·002″ T / 0·005″ L	0·010″ L	
		Barrel bore . . .	7·250″ / 7·255″	7·262″			
		Shim plate and shim plate chafing ring diameter.	7·250″ / 7·252″	7·240″			

SECTION I.

GENERAL ASSEMBLY—*continued*

FIG. 15.

Diagram reference No.	V.P. airscrew type.	Parts and description.	Dimensions, new.	Permissible worn dimension.	Clearance, new.	Permissible worn clearance.	Remarks.
6	4/1	Cylinder base bore	3·625″/3·627″	3·637″			
		Piston diameter	3·615″/3·617″	3·605″			
	5/1, 5/2 & 5/3	PISTON IN CYLINDER BASE BORE. Cylinder base bore	4·187″/4·189″	4·199″	0·008″ L/0·012″ L	0·020″ L	
		Piston diameter	4·177″/4·179″	4·167″			
7	4/1, 5/1, 5/2 & 5/3	Fit thicker shim plate when torque loading falls below 50 ft. lbs.					
8	4/1, 5/1, 5/2 & 5/3	*Spider—Cone Seat*					When wear shown on cone seat exceeds 20 per cent. of total area, re-grind or lap seat.
9	4/1	*Internal diameter*	6·750″/6·755″	6·770″			Maximum grinding allowance.
	5/1, 5/2 & 5/3	*Barrel* *Internal diameter*	7·250″/7·255″	7·270″			
10	4/1, 5/1, 5/2 & 5/3	*Cylinder*—Bore	4·500″/4·502″	4·531″			Bore must be of fair contour without depressions or sharp edges.

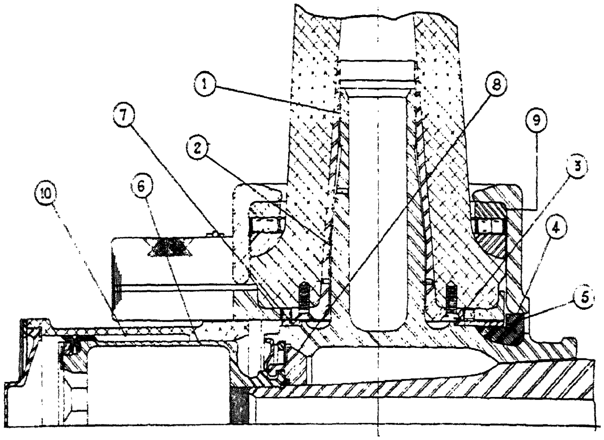


Fig. 15.—GENERAL ASSEMBLY.

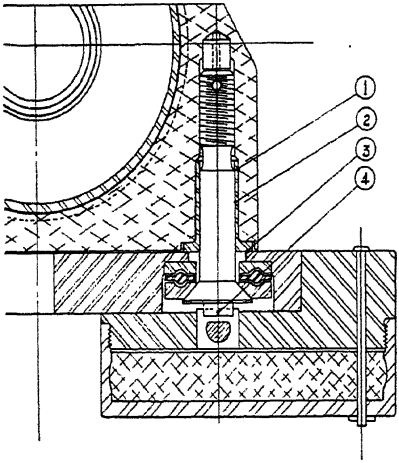


Fig 16.—THRUST RACE ASSEMBLY.

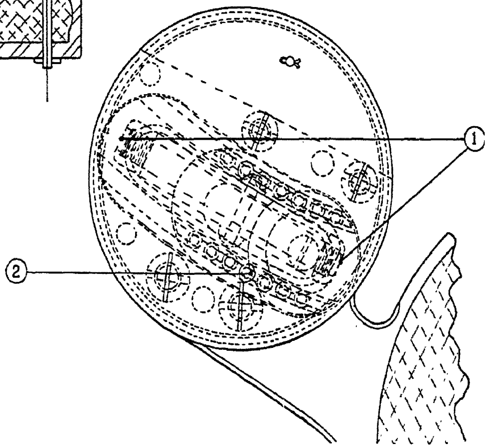


Fig. 17.—COUNTERWEIGHT, COUNTERWEIGHT BRACKET AND THRUST RACE ASSEMBLY.

SECTION II.

THRUST RACE ASSEMBLY

FIG. 16.

Diagram reference No.	V.P. airscrew type.	Parts and Description.	Dimensions, new.	Permissible worn dimension.	Clearance, new.	Permissible worn clearance.	Remarks.
1	4/1, 5/1 5/2 & 5/3	Cylinder bore	$\frac{0{\cdot}624\frac{1}{2}''}{0{\cdot}625\frac{1}{2}''}$	0·627½"	$\frac{0{\cdot}000''}{0{\cdot}002''}$ T	0·001" L	
		BEARING SHAFT BUSHING IN CYLINDER. Bearing shaft bushing diameter.	$\frac{0{\cdot}625\frac{1}{2}''}{0{\cdot}626\frac{1}{2}''}$	0·623½"			
2	4/1	Bearing shaft bushing bore.	$\frac{0{\cdot}521\frac{2}{10}''}{0{\cdot}531\frac{7}{10}''}$	$0{\cdot}533\frac{2}{10}''$	$\frac{0{\cdot}000\frac{1}{2}''\text{ L}}{0{\cdot}001\frac{1}{2}''\text{ L}}$	0·002½" L	
	5/1, 5/2 & 5/3	BEARING SHAFT IN BUSH					
		Bearing shaft diameter	$\frac{0{\cdot}530\frac{2}{10}''}{0{\cdot}530\frac{7}{10}''}$	$0{\cdot}528\frac{7}{10}''$			
3	4/1, 5/1, 5/2 & 5/3	BEARING SHAFT BUSHING FLANGE AND COUNTERWEIGHT BRACKET.			$\frac{0{\cdot}000''}{0{\cdot}003''}$ (clearance)		0·031"
4	4/1, 5/1, 5/2 & 5/3	STOP NUTS WILL WEAR A SEAT ON HEAD OF COUNTERWEIGHT BEARING SHAFT.					No replacement necessary.

COUNTERWEIGHT AND COUNTERWEIGHT BRACKET AND THRUST RACE ASSEMBLY

SECTION III. FIG. 17.

Diagram reference No.	* V.P. airscrew type.	Parts and description.	Dimensions, new.	Permissible worn dimension.	Clearance, new.	Permissible worn clearance.	Remarks.
1	4/1 5/1	Counterweight slot	3·417″ 3·421″	3·435″	0·002″ L 0·010″ L	0·020″ L	
		Counterweight Adjusting Screw (End Clearance) in Counterweight Slot.					
	5/2 & 5/3	Counterweight adjusting screw.	3·411″ 3·415″	3·397″			
2	4/1, 5/1, 5/2 & 5/3	Counterweight Bearing Cage.					Scrap cage if cracked or if more than $\frac{1}{3}$rd of the balls are badly worn.

TOLERANCES OF SIMILARITY

	Type 4/1.		Types 5/1, 5/2, 5/3.	
	Inboard of 30″ station.	30″ station to tip incl.	Inboard of 36″ station.	36″ station to tip incl.
Blade width . .	± 0·070″	± 0·070″	± 0·080″	± 0·070″
Blade thickness . .	± 0·040″	± 0·040″	± 0·050″	± 0·040″
Edge alignment . .	± 0·070″	± 0·070″	± 0·070″	± 0·070″
Face alignment . .	± 0·070″	± 0·070″	± 0·070″	± 0·070″
Template fit . .	± 0·040″	± 0·030″	± 0·050″	± 0·030″
Blade angle . . .	± 0·5°	± 0·20°	± 0·5°	± 0·20°
Longitudinal location of stations . . .	± 0·015″	± 0·015″	± 0·015″	± 0·015″
Blade length . .	± 0·070″		± 0·070″	

diagram, and each bears a numerical reference. These reference numbers correspond with the reference numbers quoted in column 1 of the appropriate section of the schedule, against those components between which wear occurs or in which distortion is liable to take place.

10. Parts worn beyond the limits given in this schedule should be returned to the manufacturers, who will, as a rule, be able to restore them for further service by fitting oversize or undersize complementary parts to provide the original working clearances.

SCHEDULE OF REPAIR TOLERANCES OF BLADES FOR VARIABLE-PITCH AIRSCREWS

Types 4/1, 5/1, 5/2 and 5/3.

1. Repair Tolerances

All nicks, dents and scratches on blades must be erased with a smooth file and smoothed out with fine emery cloth—from being sharp cornered indentations they must be made into smooth rounded depressions (see also page 230).

Caution.—Blade repair must not be undertaken where limitations or damage given in following table are exceeded :—

Shank must be within drawing tolerances.
Inner $\frac{2}{3}$ of blade, X must not exceed 0·025W.
Inner $\frac{2}{3}$ of blade, Y must not exceed ·025T.
Outer $\frac{1}{3}$ of blade, X must not exceed ·050W.
Outer $\frac{1}{3}$ of blade, Y must not exceed ·050T.
Outer 12″ of blade, X must not exceed ·100W.
Outer 12″ of blade, Y must not exceed ·100T.
Outer 6″ of blade may be repaired as required.

Where these limits of damage are exceeded it will normally be possible to restore the blade to a new drawing number, for which purpose it should be returned to the manufacturers.

2. Tolerances of Similarity

It will often occur that blades returned to the manufacturers for repair will require to be re-shaped along the edges or at the tip, and where the damage is extensive the blade will be restored to a new drawing number and will then only be suitable as spare on a different type of airscrew—usually of less diameter.

Where, however, the damage is only slight, the blades will be restored at, as nearly as possible, the original dimensions, in order that they may be held as spare and used in the type airscrew for which they were designed originally.

Such blades will be adjusted for balance as described in the section on balancing, but in order that they may be also in aero-dynamic balance it is necessary to limit the amounts by which they vary from the other blades in their similar dimensions.

These tolerances are given in tabulated form on the previous page, and wherever possible spare blades within these tolerances should be fitted, but should they not be available then the larger blades in the airscrew must be refinished to the size of the smallest within the similarity tolerance.

MAINTENANCE AND OVERHAUL INSTRUCTIONS FOR THE "CIRRUS MINOR" 80-90 H.P. ENGINE

By J. G. Goby,

Works Manager, Engine Dept., Blackburn Aircraft Ltd.

OWING to the simplicity of design the " Cirrus Minor " engine requires very little in the way of maintenance, but as in the case of all new engines, several points require attention at an earlier stage than would be necessary when it had run quite a number of hours.

After Ten Hours Running

It is advisable, for instance, to remove for cleaning the " oil filter " after the first ten hours running, as it is found that the accumulation of sludge, accelerated by new tanks, pipe lines, etc., is heavier during this period.

This also applies to the " fuel filters " when pumps are fitted, and these should therefore be removed, flushed with petrol and replaced.

Oil should be changed in the tank after the same period, to ensure freedom from impurities and metallic particles.

Jets should be removed from carburetter, washed, cleaned and replaced.

After Fifty Hours Running

All the foregoing should then be repeated after every fifty hours running, together with the remaining items that are hereunder enumerated.

Check for tightness the airscrew bolts, which, incidentally, will require more attention in hot climates.

Clean, reset and test the sparking plug points, and see that the insulation is free from cracks or dirt.

Check magneto contact breaker gaps and reset if necessary.

Valve clearances should also be inspected, and if incorrect, reset.

Attention should be given to all small oil holes, and the grease gun used on the control rods, which have nipples provided.

Rubber jointings in the oiling system should be inspected for any possible leakage.

No other maintenance than the above, at fifty-hour periods, should be necessary, until a flying period of 300 hours has been reached, when the engine must be " top overhauled."

TOP OVERHAUL

After Three Hundred Flying Hours

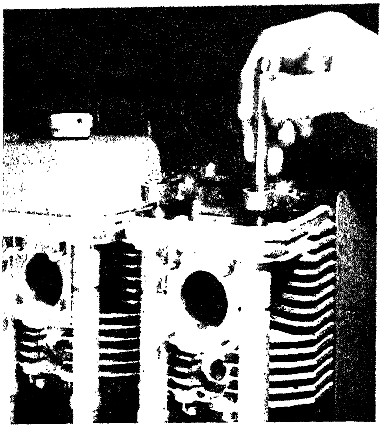


Fig. 1.—WITHDRAWING PUSH RODS.

With the rocker arms held in a level position, the push rods are easily withdrawn.

Although with proper care and maintenance the " Cirrus Minor " aero engine will still be running smoothly, and up to standard, it is laid down that after a period of 300 hours flying certain parts must be taken off for cleaning and inspection.

The object of this is, that after this period some of the component parts may be suffering from the effects of the carbon deposit in the engine and " gumminess " from the oil, and if allowed to run for longer periods would, due to these causes, be prematurely worn so far as to render them useless for any further service, with the inevitable result of a costly bill for spare parts.

With the object of preventing this occurrence the specific period of 300 hours is strictly adhered to and armed with the necessary tool kit supplied, the engineer should proceed as follows :—

Dismantling for Top Overhaul

When necessary, for convenience sake, remove the airscrew and " nose " cowling, which is a simple matter after the " spinner " and lock plates have been removed.

Withdraw the long pin securing the cowling, which will then come away quite easily.

Next remove the exhaust pipe stubs, and after disconnecting control rods, remove the induction pipe (complete with carburetter).

To remove the rocker boxes, which are secured with a self-locking knob, pull the knob away from the box and unscrew.

Fuel feed pipe should be disconnected at this stage, high-tension leads taken off, and all sparking plugs removed with care.

On the end of the rocker arms will be found the adjusting screws for tappet clearances, these can, after removing the lock washer, be unscrewed, and through the aperture left the push rods may be withdrawn (Fig. 1)

Next lift the telescopic covers over the ends of the tappet guides and remove.

The cylinder heads and cylinders should be removed together, which is accomplished by unscrewing sixteen nuts at the cylinder bases.

It would be advisable to remove the rings from the exposed pistons, with the help of thin strips of steel, gently inserted behind them.

Extract the circlips from the gudgeon-pin bores with the special tool and slide out the pins.

To take apart the cylinders and heads, remove the lock tabs and nuts from the upper rims of the cylinders.

Should any difficulty be experienced in parting these units, a smart blow on a block of wood up through the barrel will release them, but on no account must they be prised apart at the joint faces, as damage to the faces and copper washer is bound to occur.

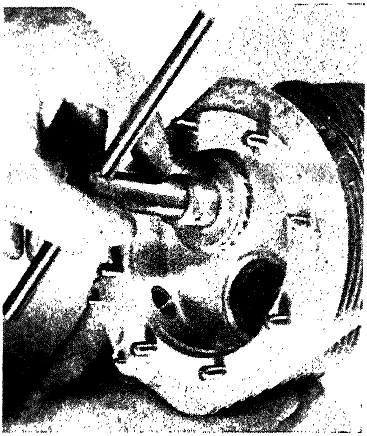


Fig. 2.—VALVE SEATING.

With a steady even pressure on the cutter the valve seatings are recut when necessary.

By removing the circlips and washers on the rocker brackets, the arms may be easily slid off.

Valves are now removed by depressing the collars and springs and the split collets taken out.

Remove Carbon and Wash Parts

This is as far as the engine is dismantled for "top overhaul," and the removal of all carbon deposits is now proceeded with and all parts thoroughly washed.

Thoroughly clean this carbon from the combustion chambers, tops of pistons and ring grooves.

The inside faces of the rings should also receive this attention.

Attention to Valve Seatings, Valves and Guides

Examine the valve seatings and seat inserts in the heads for pitting, and should any show too much "pocketing" for removal by grinding in, they should be gently recut, with the valve seating cutter provided (Fig. 2).

Clean the stems of the valves and the bores of the valve guides and examine same for wear.

Compare the size obtained with the wear tolerance chart, to be sure those stated on the latter are not exceeded.

Grind in the valves with a fine abrasive, all trace of which must be subsequently removed and with the valves assembled in position, complete with springs, collars, etc., check for seating by filling the combustion chamber with paraffin.

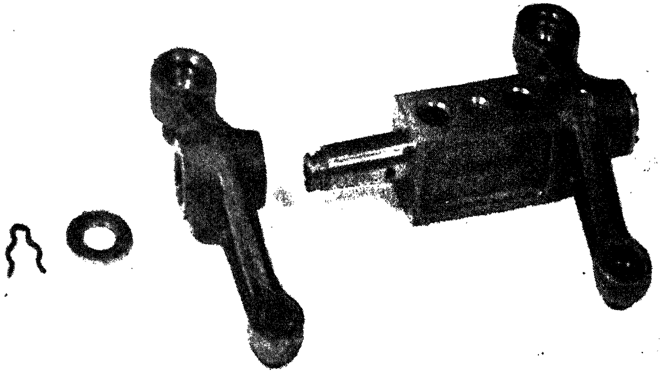


Fig. 3.—ASSEMBLY OF ROCKER BRACKET AND ARMS, SHOWING DETAILS.

Wash out the rocker arm bushes, balls at the ends, and reassemble complete with washers and circlips (Fig. 3).

Attention to Cylinders and Pistons

Next examine the cylinders for ovality, wear and scoring.

Check the size of pistons, on diameter and in ring grooves for wear.

The rings should be checked for free gap, and running gap may be checked by placing the rings in the head end of the cylinder and inserting feelers (Fig. 4).

Any signs of "blowing" on the ring surface will necessitate renewal.

Fig. 4.—CHECKING RING GAP WITH "FEELER GAUGE.

Test Induction Pipe for Leaks

If at all possible the induction pipe should be pressure tested to 20 lbs. for leaks.

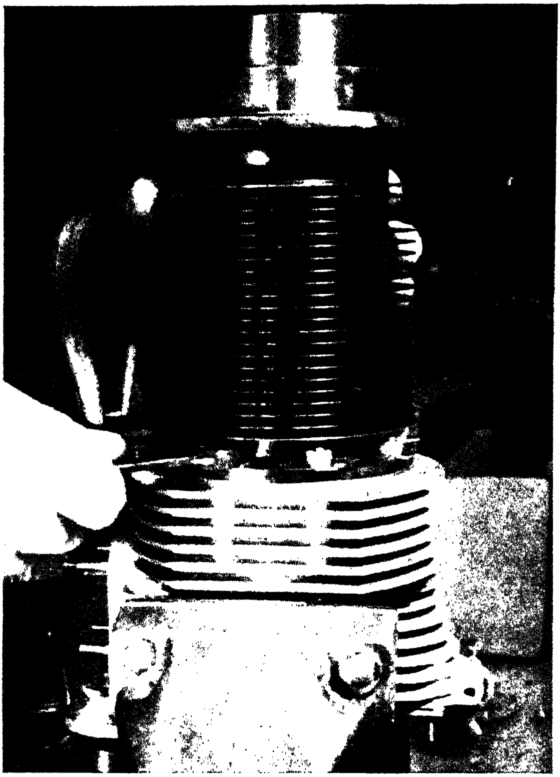


Fig. 5.—CYLINDER HEAD NUTS MUST BE TIGHTENED EVENLY ROUND THE HEAD.

Attention to Carburetter, Magnetos, Filters and Oil Pipes

Dismantle the carburetter, clean, wash out and reassemble to the makers' instructions.

Examine contact breakers of magnetos and adjust joints, if necessary.

Adjust and clean sparking plug points.

Any high-tension leads that show signs of bad chafing or cracking should be renewed.

Lastly, wash out filters and all oil pipes that have been dismantled.

Reassembling after Top Overhaul

With everything in a thoroughly clean condition, reassembly may be commenced and proceeded with in the following order :—

Refit cylinder heads to cylinders, evenly tighten all the nuts, finally locking the tab washers (Fig. 5).

Place pistons on connecting rods, insert gudgeon pins and circlips, making sure the latter are nicely bedded in their grooves.

Carefully fit the piston rings, taking care that the scraper ring is fitted in the grooves furthest from the crown and adjacent to the ring of drain holes.

Oil the assembled pistons and the inside of the cylinder barrels, which may be placed into position, after making sure that the large dermatine joint ring is in good condition. A stretched or faulty ring will cause oil leaks.

Tighten the cylinder holding down nuts and secure by bending the tab washer, but while engaged on this operation line up the port faces by use of a straight edge (Fig. 6).

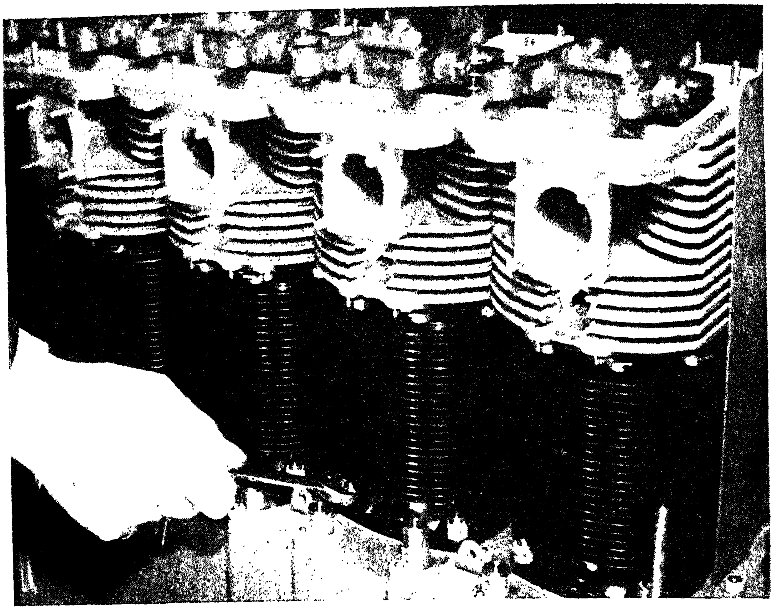


Fig. 6.—CYLINDER BASE BOLTS TIGHTENED DOWN AND SECURELY LOCKED BY TAB WASHERS.

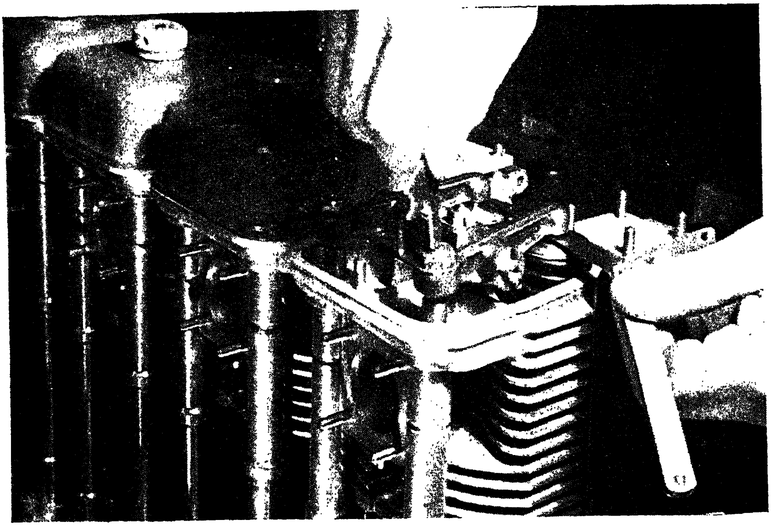


Fig. 7.—TAPPET CLEARANCES ARE SET BY MEANS OF ADJUSTING SCREWS AT ROCKER ENDS.

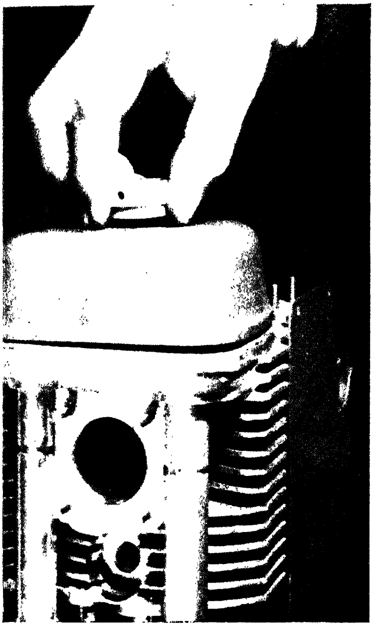


Fig. 8.—Taking off rocker boxes by pulling the knob in a downward direction to free from the locking pin, and unscrewing.

Fit cylinder baffle plate, and push rod cover tubes.

Slip the push rods through the holes in rocker arms and insert adjusting screw sockets.

Set tappet clearances to 0·004 in. (Fig. 7), and secure by lock tabs.

Replace induction pipe with carburetter and connect up all controls.

Replace in order, sparking plugs, high-tension leads, side cooling chute and exhaust stubs.

Connect fuel feed pipes, and after filling rocker boxes to correct level with oil, screw home into position.

Lastly refit front cowling and airscrew, paying special attention to the locking of all nuts.

COMPLETE OVERHAUL

After Six Hundred Flying Hours

After a period of 600 flying hours the "Cirrus Minor" engine should be taken from the airframe and completely overhauled, and as it is advantageous in every respect that this should follow a strict routine, it is here proposed to set out, step by step, the correct sequence of operations necessary to dismantle and subsequently rebuild it.

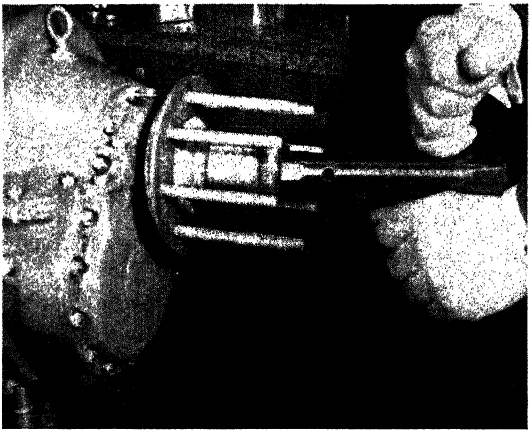


Fig. 9.—Using the extractor to remove the airscrew hub.

Removing Engine from Airframe

Before removing the engine from the airframe it will be necessary to first of all remove the airscrew, disconnect all oil pipes, fuel pipes, tachometer drive, earth and switch wires, and controls.

Remove the bolts

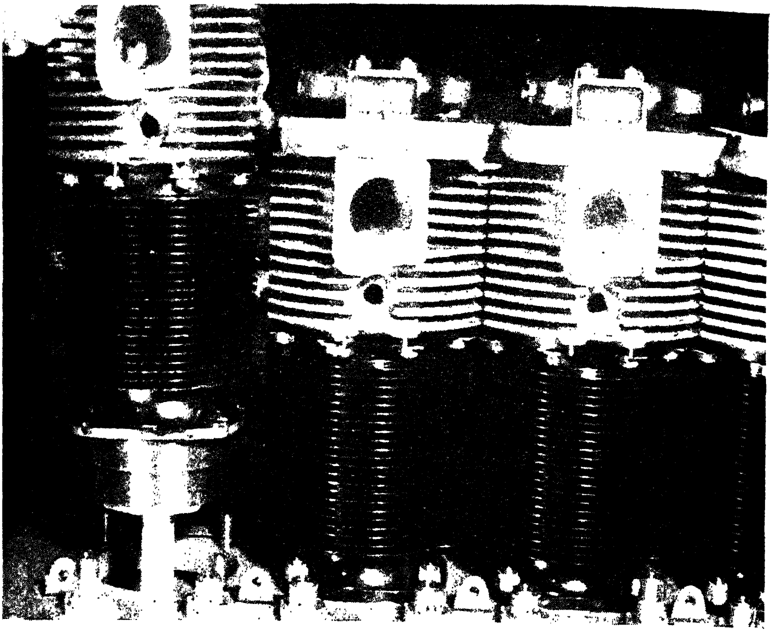


Fig. 10.—REMOVING THE CYLINDERS WITH HEADS.

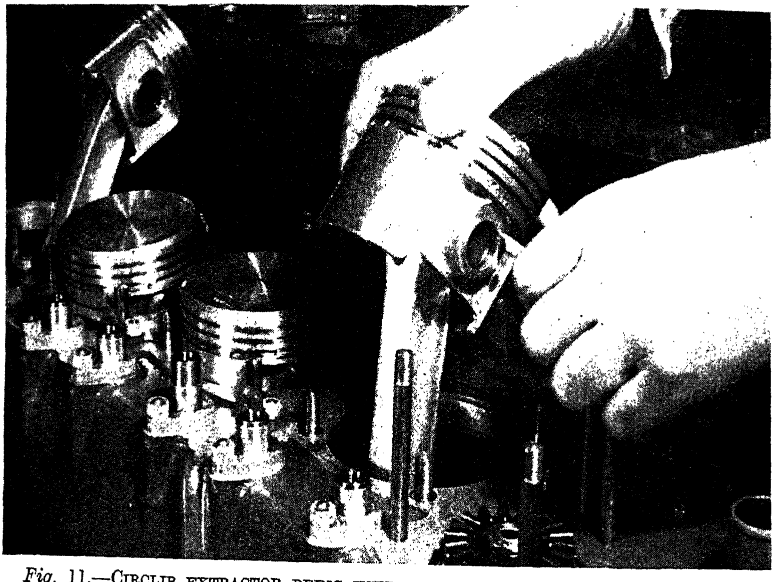


Fig. 11.—CIRCLIP EXTRACTOR BEING USED BEFORE REMOVING THE GUDGEON PINS.

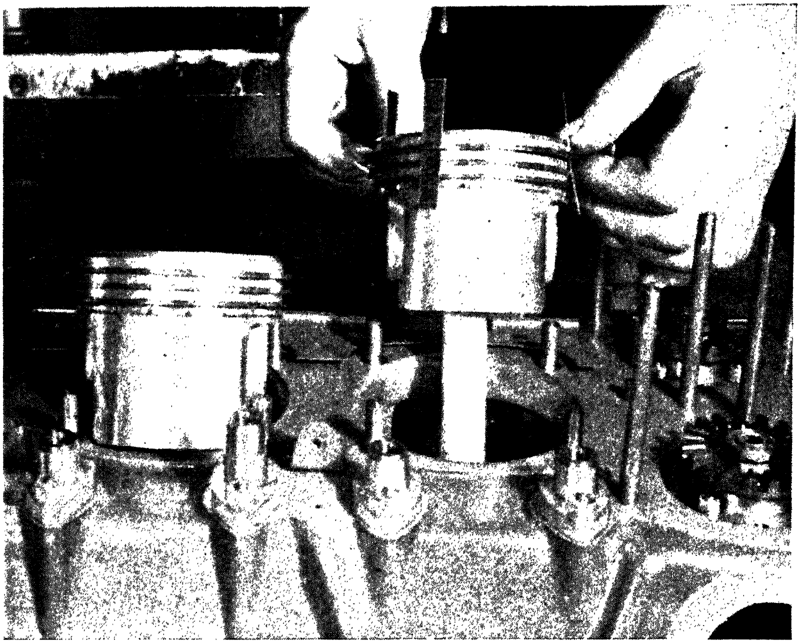


Fig. 12.—REMOVING THE PISTON RINGS WITH THE AID OF THIN PIECES OF STEEL.

from the bearer feet, and lift the engine by a sling, which should already be in position, and connected to the lifting eyes, situated on the top cover.

While held by the sling remove the rest of the cowling and cooling baffle plates, then gently place in position on the engine stand, still in an inverted position.

Dismantling the Engine

Unscrew all sparking plugs and remove the high-tension leads.

Unscrew rocker boxes and empty the oil (Fig. 8).

After straightening the locking tab on the hub nut, this may be unscrewed and the hub withdrawn by use of the extractor (Fig. 9).

To hold the crankshaft from turning, while removing the nut, the airscrew should be temporarily placed into position on the long bolts, which will then take the thrust.

The engine should now be reversed in position on the stand, *i.e.*, with the cylinder heads uppermost and the starter (if fitted) removed.

Next, remove the magnetos and magneto platforms.

By use of the special universal spanner remove the sixteen nuts securing the induction pipe, when the whole unit, including the carburetter, will come away.

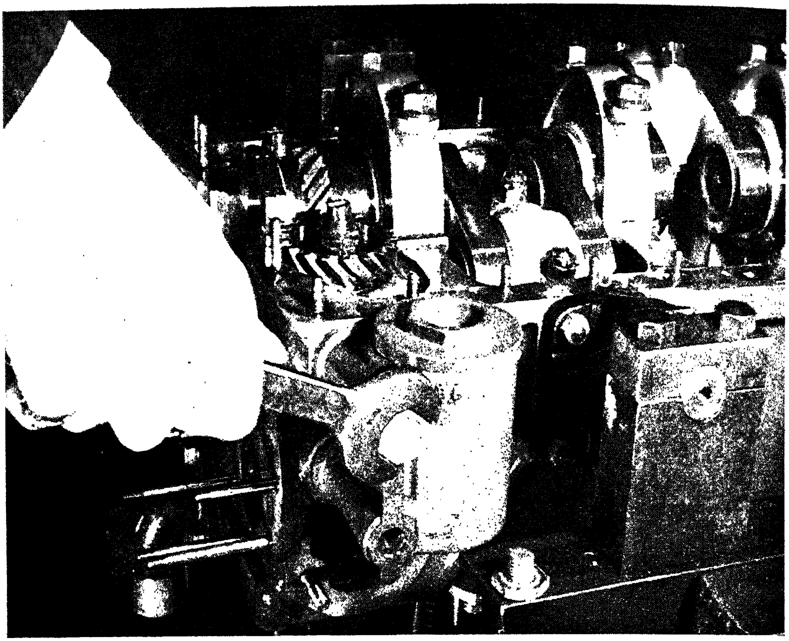


Fig. 13.—Removing filter body.

After next removing the sixteen cylinder base nuts, the cylinders, complete with heads, may be withdrawn from the crankcase (Fig. 10).

With the help of the extractor remove the circlips from the gudgeon-pin bores (Fig. 11), when the pins themselves may be easily withdrawn.

Carefully take the rings from the pistons and, to avoid breaking, this operation may be facilitated by the use of thin pieces of pen steel (Fig. 12).

Remove tappet guides and tappets, also filter cover, and take out the gauze element, which may be taken apart for cleaning by removing the split pin at the end of the perforated spindle (Fig. 14).

Remove oil filter body (Fig. 13), fuel

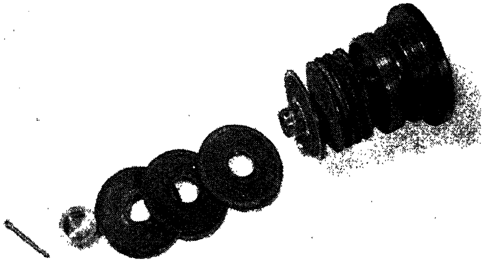


Fig. 14.—Details of filter element after taking apart.

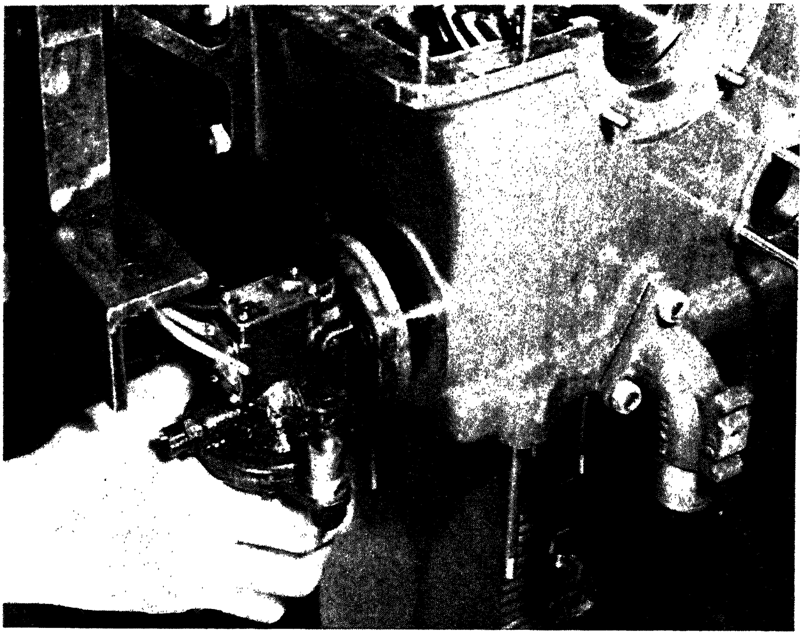


Fig. 15.—REMOVING FUEL PUMPS.

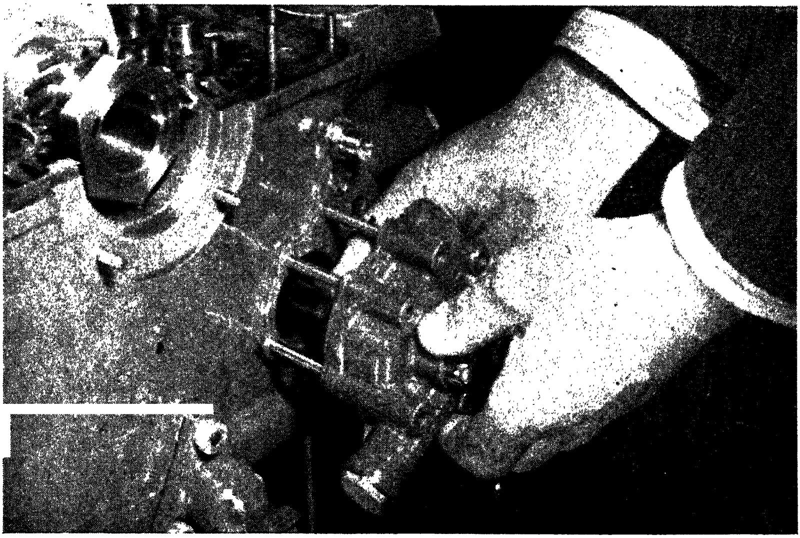


Fig. 16.—OIL PUMP BEING WITHDRAWN FROM CRANKCASE COMPLETE WITH DRIVING TUBE.

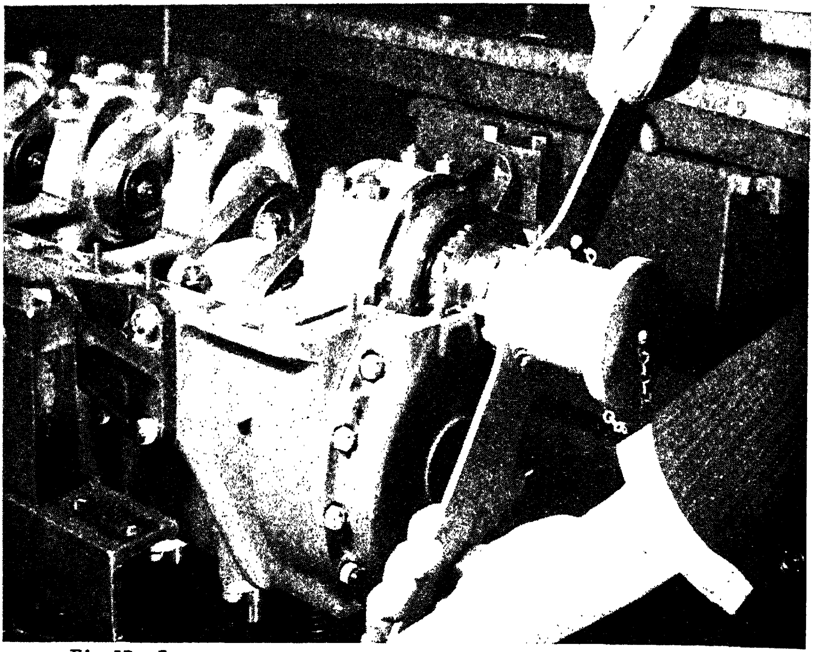


Fig. 17.—LEFT-HANDED THRUST NUT BEING REMOVED FROM CRANKSHAFT.

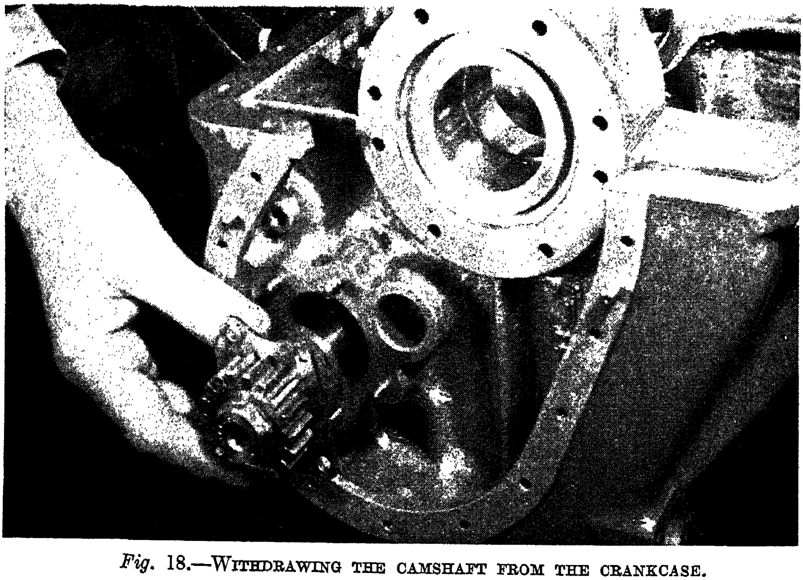


Fig. 18.—WITHDRAWING THE CAMSHAFT FROM THE CRANKCASE.

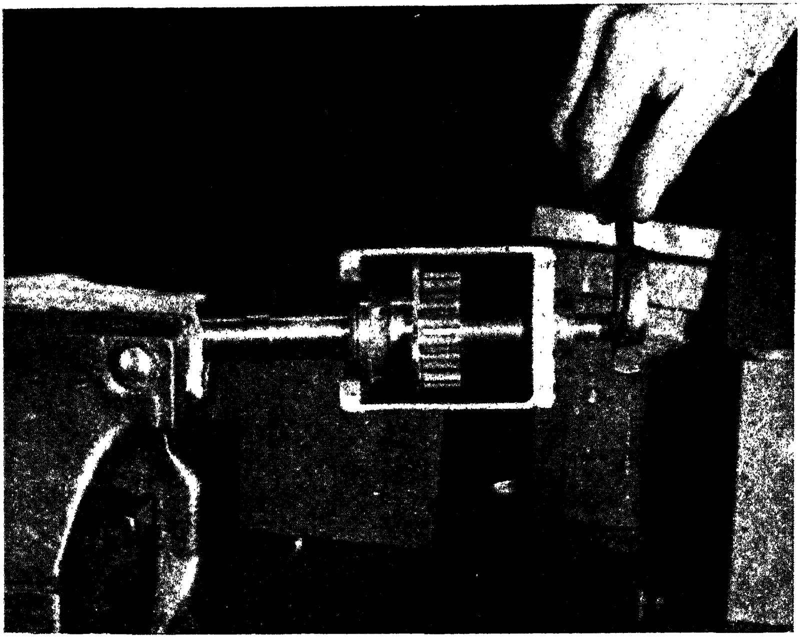


Fig. 19.—WITHDRAWING THE CAMSHAFT WHEEL FROM THE SHAFT WITH THE SPECIAL EXTRACTOR.

pumps (Fig. 15) and oil pump. The loose driving tube is withdrawn with the latter (Fig. 16), and take off timing cover.

Removing Crankshaft and Camshaft

Turn the engine once again on the stand and remove thrust and top covers.

Remove split pins, unscrew bolts of big ends, and take the caps apart from the rods.

The left-handed thrust nut on the crankshaft should next be unscrewed and the oil thrower removed (Fig. 17).

Remove the locking tab and nut from idler spindle, when the wheel may be pulled off. Care must be taken to catch the needle rollers, upon which this revolves.

Continue by removing the ball race, thrust housing and main bearing caps and gently lift crankshaft from case.

The camshaft may be drawn bodily from the crankcase complete with front bearing, after removing locking wire and nuts (Fig. 18).

The wheel should be withdrawn by means of the extractor provided (Fig. 19).

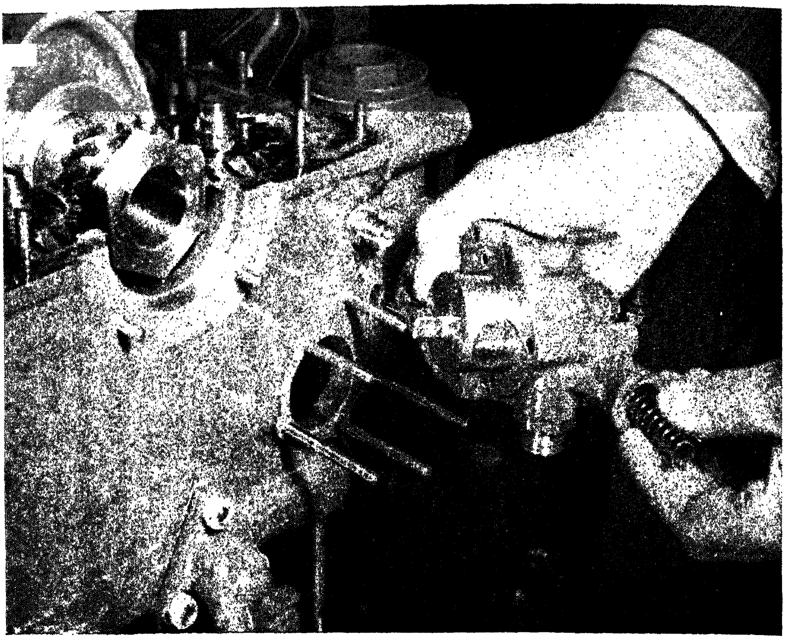


Fig. 20.—Dismantling oil pump.
Showing rotor, piston and oil relief valve.

Dismantle oil pump by withdrawing the rotor, which in turn contains the piston and oil relief valve (Fig. 20).

Remove the oil seals on the crankshaft, this being necessary for washing out the accumulation of oil sludge.

To remove the magneto drive spindles a special locking device is engaged on the "Simms" couplings, and with these rigidly held in this manner, the nuts at the helical gear ends may be removed.

Next, extract the "Simms" couplings, and remove the leather oil seals, with housings (Fig. 21).

The shafts may then be tapped out of the crankcase.

Remove the cylinder heads from the cylinders and dismantle as per instructions on "Top Overhaul."

All parts are now subject to a thorough washing and cleansing process and laid out for inspection.

Checking Wear of Parts

Every part subject to wear is now checked against the tolerances allowed on the chart, and if any are found to be exceeded the component must be replaced by a new one.

Special attention should be paid to the following points:—

Wear in valve guides, and valves to be polished and closely scrutinised for cracks.

Cylinder barrels for scoring and ovality.

Piston rings for wear and gaps.

Pistons for scoring, ovality and wear in ring grooves.

Connecting rods for ovality and wear in gudgeon-pin bores, also for cracks.

Big end bearings for wear, side and diametrical clearance and any bad adhesion of white metal.

Crankshaft for wear and ovality of pins and journals. Any signs of picking up on the hub taper must be removed by lapping with a fine abrasive.

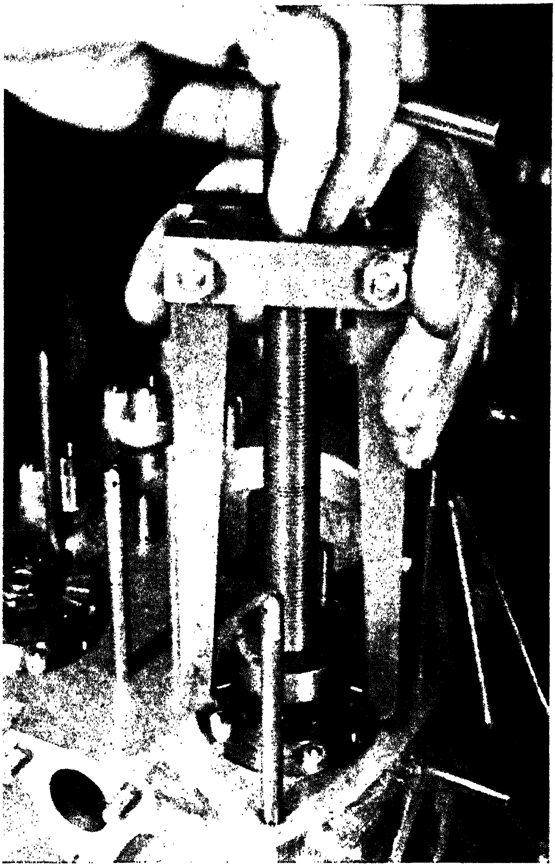


Fig. 21.—EXTRACTING FLEXIBLE COUPLINGS FROM SHAFTS TO REMOVE THE LEATHER OIL SEALS.

Crankcase should be inspected for cracks and tightness of studs.

Main bearings for signs of cracking or bad scoring.

Camshaft should be checked for concentricity and wear on cam faces.

Undue wear on these or the tappets should be stoned off.

Check gears for wear and tooth deformation.

Induction pipe should be pressure-tested for leaks.

All the remaining parts of the engine must also be rigidly examined for any faults and renewals made if necessary.

The magnetos and carburetter are inspected to instructions issued by the makers.

Rebuilding

After the condition of all parts has been thoroughly reviewed and replacements made where necessary, the engine is rebuilt in exactly the reverse way to the dismantling, but it is advisable to renew all washers, gaskets and rubber oil joints.

Although the foregoing article deals exclusively with the "Cirrus Minor" aero engine, and some of the operations, of necessity, are peculiar only to this product, it can be taken that broadly the same principle of maintenance and overhaul will apply to any similar "straight line" four-cylinder inverted, aero engine.

CIRRUS MINOR CLEARANCES

PART.	Clearance when New.		Maximum Clearance allowed for a further 300 Hours Running.	Maximum Clearance allowed for a further 600 Hours Running.
	Minimum	Maximum.		
MAIN BEARINGS.				
On diameter	**0·013 mm.** 0·0005 in.	**0·062 mm.** 0·0025 in.		**0·076 mm.** 0·003 in.
Side clearance (front bearing only) each side	**0·75** 0·030	**1·75** 0·070		
Side clearance (remainder of bearings) each side	**0·75** 0·030	**2·75** 0·108		
CONNECTING ROD BIG END BEARINGS.				
On diameter	**0·000** 0·000	**0·049** 0·002		**0·076** 0·003
End float	**0·10** 0·004	**0·226** 0·009		**0·30** 0·012
CAMSHAFT BEARING FRONT Only.				
On diameter	**0·032** 0·00125	**0·095** 0·0038		**0·127** 0·005
End float	**0·050** 0·002	**0·250** 0·010		**0·33** 0·015
CAMSHAFT BEARINGS INTERMEDIATE.				
On diameter	**0·025** 0·001	**0·101** 0·004		**0·152** 0·006
CYLINDERS.				
Ovality				**0·127** 0·005
Taper				**0·127** 0·005

PART.	Clearance when New.		Maximum Clearance allowed for a further 300 Hours Running.	Maximum Clearance allowed for a further 600 Hours Running.
	Minimum	Maximum.		
PISTON (on diameter in Cylinder).				
Skirt	**0·435** 0·017	**0·535** 0·021	**0·635** mm. 0·025 in.	
3rd Land	**0·505** 0·020	**0·605** 0·024	**0·736** 0·029	
2nd Land	**0·585** 0·023	**0·685** 0·027	**0·813** 0·032	
1st Land (nearest crown)	**0·675** 0·0265	**0·775** 0·0305	**0·890** 0·035	
(*Readings to be taken at ½ stroke position.*)				
PISTON RINGS (Side Clearance).				
1st Ring (nearest crown)	**0·203** 0·008	**0·253** 0·010	**0·330** 0·013	
2nd Ring	**0·127** 0·005	**0·178** 0·007	**0·253** 0·010	
3rd Ring (Scraper)	**0·088** 0·0035	**0·138** 0·0055	**0·203** 0·0085	
Gap on all rings (at ½ stroke position)	**0·228** 0·009	**0·457** 0·018	**0·508** 0·020	
GUDGEON PIN.				
On diameter in piston and connecting rod	**0·000** 0·000	**0·026** 0·001	**0·039** 0·0015	
End float between circlips	**1·55** 0·061	**1·85** 0·073	**2·03** 0·080	
CONNECTING ROD.				
Side clearance in piston	**0·75** 0·030	**2·75** 0·108		**2·75** 0·108
MAGNETO DRIVE SHAFT.				
Oil thrower clearance from housing	**0·125** 0·005	**0·213** 0·0085		**0·213** 0·0085
Backlash on gears	**0·125** 0·005	**0·25** 0·010		**0·508** 0·020
Simms coupling end float	**0·500** 0·020	**1·00** 0·040		**1·00** 0·040
(NOTE.—*Flexible coupling must not be in compression.*)				
IDLER GEAR.				
Backlash	**0·075** 0·003	**0·175** 0·007		**0·381** 0·015
End float	**0·04** 0·0016	**0·13** 0·005		**0·254** 0·010
NEEDLE ROLLERS.				
End clearance	**0·15** 0·006	**0·40** 0·016		**0·508** 0·020
Diametrical clearance	**0·005** 0·0002	**0·04** 0·0016		**0·054** 0·002

PART.	Clearance when New.		Maximum Clearance allowed for a further 300 Hours Running.	Maximum Clearance allowed for a further 600 Hours Running
	Minimum	Maximum.		
TAPPETS.				
	0·069	**0·138**		**0·203**
On flats in guides	0·0027	0·0055		0·008
	0·014	**0·045**		**0·076**
On diameter in guides	0·0005	0·0018		0·003
OIL PUMP.				
	0·013	**0·053**		**0·076**
Rotor on diameter	0·0005	0·002		0·003
	0·172	**0·222**		**0·305**
,, end float	0·007	0·009		0·012
	0·003	**0·027**		**0·038**
Piston in rotor on diameter	0·0002	0·001		0·0015
	0·01	**0·04**		**0·054**
Bearing block side clearance	0·0004	0·0016		0·002
	0·125	**0·30**		**0·381**
,, ,, end float	0·005	0·012		0·015
	0·013	**0·037**		**0·054**
Pin in bearing block on diameter	0·0005	0·0015		0·002
	0·003	**0·027**		**0·381**
Relief valve piston on diameter.	0·0002	0·001		0·0015
VALVES. In Guides.				
	0·077	**0·102**	**0·203**	
On diameter	0·003	0·004	0·008	
VALVE CLEARANCE.				
	0·10	**0·10**	**0·10**	**0·10**
Cold	0·004	0·004	0·004	0·004
VALVE ROCKER BUSHES.				
	0·019	**0·057**	**0·127**	
In bore on pin.	0·0008	0·0025	0·005	
	0·075	**0·38**	**0·540**	
End float	0·003	0·015	0·020	
THRUST RACE NUT.				
	0·637	**0·713**		**0·713**
On diameter in front cover	0·025	0·028		0·028
OIL THROWER FRONT.				
	0·36	**1·0**		**1·0**
Clearance from timing cover	0·014	0·040		0·040
TACHOMETER DRIVE SPINDLES.				
	0·012	**0·045**		**0·054**
On diameter in bush	0·0005	0·0016		0·002

NOTE.—*Heavy Figures show Dimensions in Millimetres.*

N.B.—The clearances are shown in three groups. Firstly, the new clearances, secondly, the maximum clearance permissible where a part will be refitted at top overhaul for a further period of 300 hours running, and in the last column the maximum clearances allowed for parts which are to be reassembled at complete overhaul for a further period of 600 hours running.

It will be seen that these parts are such items as will only be disturbed at complete overhaul periods.

THE ROLLS-ROYCE KESTREL CARBURETTER

By E. W. Knott, M.I.A.E., M.S.A.E.

THIS carburetter is entirely designed and built by Rolls-Royce Limited and is their latest model for the Kestrel engines. It is of the twin barrel type, *i.e.*, with two throttle bores, two choke tubes, etc., fed by a common air intake. A pilot jet and a small auxiliary diffuser is incorporated and are solely for starting and small throttle openings. The point where the mixture enters the air stream can be adjusted so that it varies relative to the edge of the throttle valve and this adjustment enables the blending of the slow running and main mixtures to be adjusted so that no irregularity or flat spots occur as the throttle is opened up. This small diffuser system is fitted with a filter.

Control of Main Fuel Supply

Control of the main fuel supply by the pilot is obtained by rotary fuel valves which he can alter according to varying altitudes, etc. Acceleration with quick throttle opening is assured by an accelerating pump built into the carburetter which injects a temporary discharge of fuel into the left-hand choke through a nozzle provided for that purpose.

Fig. 1 shows a section through the carburetter, the upper half of which is fixed to the supercharger casing, while the air supply is drawn through a gauze covered frame held in place by the air intake flange, which usually faces forward. Referring to Fig. 1, it will be seen that fuel is delivered to the float chamber at the union A, the level being controlled by a float and needle valve B. From the float chamber fuel passes *viâ* two valves E, the valves having eccentric heads each working in its own seating. A passage from each of these seatings goes to the diffuser wells, the passages being restricted by the eccentric valves which are joined together by short levers and a connecting link and can be opened or closed by moving the pilot's lever D.

The Air Bleed

Projecting down into the diffuser wells will be seen two tubular parts, in the sides of which are a number of small holes, and the diffuser wells connect with the diffuser nozzles projecting into the chokes. The upper parts of the diffuser tubes are connected by the passages F, the annular space around the chokes and from there to the carburetter air intake. When the engine is running the air pressure on the passage F is higher

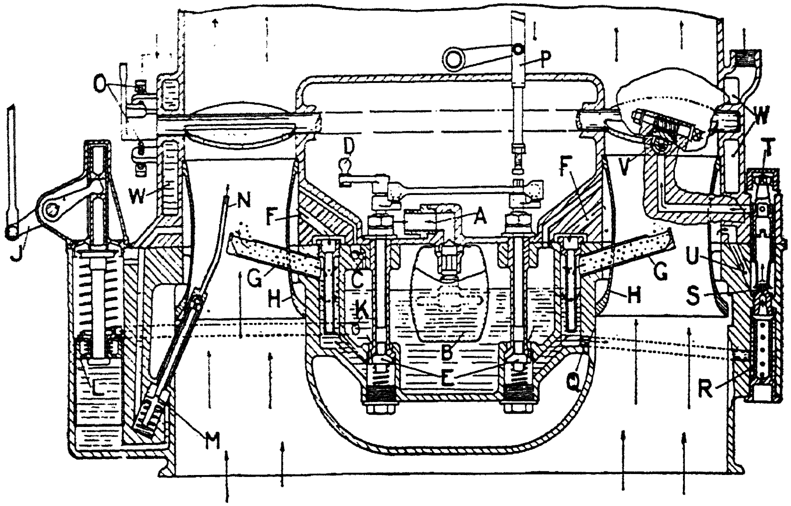


Fig. 1.—SECTION THROUGH THE ROLLS-ROYCE KESTREL CARBURETTER.

A. Fuel inlet.
B. Float.
C. F.C. air vent and ball valve for inverted flying.
D. Mixture control (main jet).
E. Eccentric varying the M.J. flow.
F. Air bleed to main diffuser.
G. Main diffuser nozzle.
H. Choke.
J. Accelerating pump lever connected to throttle control lever.
K. Fuel supply to accelerating pump.
L. Accelerating pump.
M. Spring-loaded needle valve.
N. Accelerating pump discharge nozzle.
O. Main throttle operating lever and stops.
P. Mixture strengthening device (connected to throttle operating lever).
Q. Fuel supply to S.R. jet.
R. S.R. filter.
S. S.R. jet.
T. S.R. mixture adjustment.
U. S.R. air supply.
V. S.R. adjustment plug.
W. Hot water jacket.

than in the nozzles G, with the result that air passes through small holes in the diffuser tubes and bubbles through the fuel in the diffuser well. The resulting rich emulsion passes through the tubes G into the choke tubes where it mixes with the main air supply and passes up into the supercharger intake and so to the engine. Fig. 2 shows a section through the engine and carburetter.

Slow Running

In common with many other carburetters, when the throttles are in the nearly closed or slow running position, the pressure difference between G and F is insufficient to supply fuel from the main jet system. A feed is therefore taken to a plug V opposite the lower edge of the right-hand throttle valve. This plug has the discharge orifice in it placed eccentrically, so that turning the plug will raise or lower the hole relative to the edge of the throttle valve, the hole, however, being of such a size that

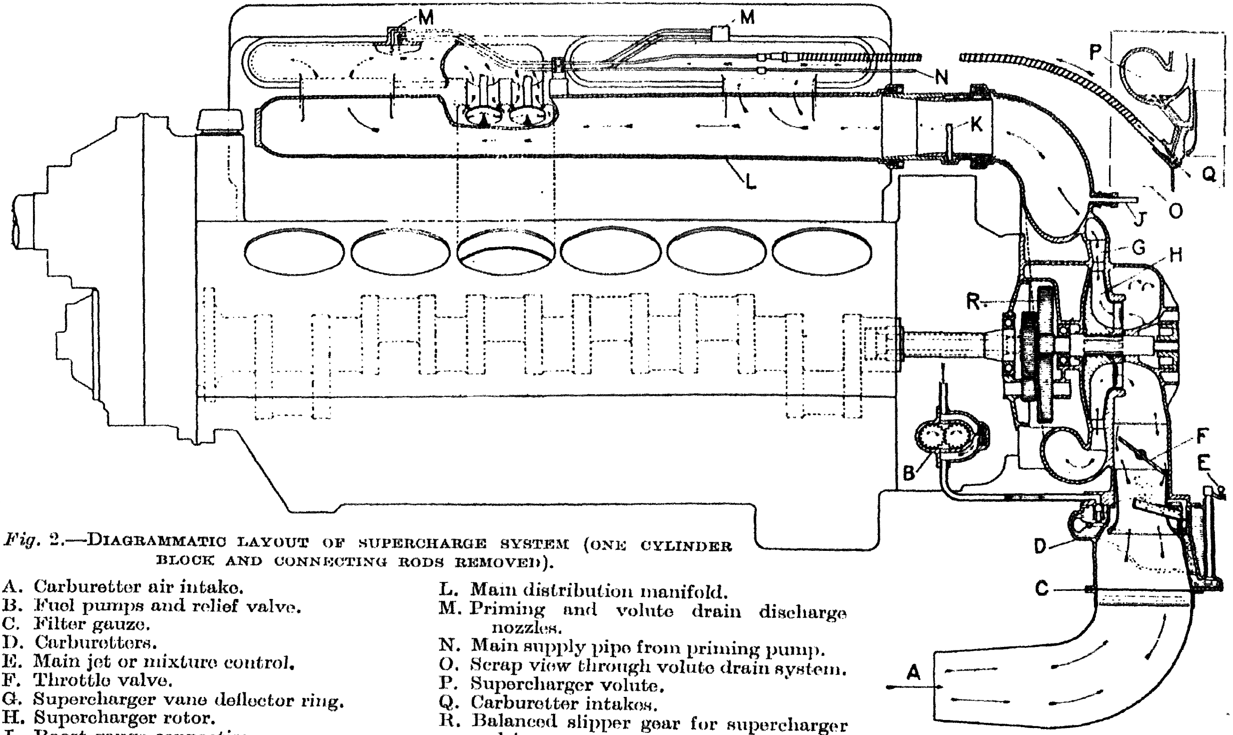


Fig. 2.—DIAGRAMMATIC LAYOUT OF SUPERCHARGE SYSTEM (ONE CYLINDER BLOCK AND CONNECTING RODS REMOVED).

A. Carburetter air intake.
B. Fuel pumps and relief valve.
C. Filter gauze.
D. Carburetters.
E. Main jet or mixture control.
F. Throttle valve.
G. Supercharger vane deflector ring.
H. Supercharger rotor.
J. Boost gauge connection.
K. Re-distribution pipe for condensed fuel.
L. Main distribution manifold.
M. Priming and volute drain discharge nozzles.
N. Main supply pipe from priming pump.
O. Scrap view through volute drain system.
P. Supercharger volute.
Q. Carburetter intakes.
R. Balanced slipper gear for supercharger drive.

part of it shows both above and below the throttle, the proportion varying with the amount of rotation given to the plug.

In this way the mixture strength issuing opposite the edge of the throttle can be varied. If a small gap is on the underside and a large one on the engine side, the mixture will be rich. If small on top and large underneath more air will enter and the mixture will be weak, any range of mixture strength between the two extremes being obtainable by turning the plug to the required position. The fuel for slow running comes from the right-hand main jet and flows to the small auxiliary diffuser, through gauze filter R and then *viâ* passage Q and jet S to the discharge plug V.

Acceleration

As explained earlier in the " Carburation " section, Volume I, if the carburetter is tuned to be economical, sudden opening of the throttle from the slow running position will cause a bad hesitation or " flat spot," as it is commonly called, and a temporary injection of fuel must accompany this sudden opening. Reference to Fig. 1 shows an accelerating pump L which is coupled to the pilot's throttle lever. When this lever is moved rapidly, the spring loaded valve M is blown off its seat and fuel is discharged into the air stream through the pump discharge nozzle N. Slow opening of the throttle does not require accelerating pump action and in such an instance the pressure is insufficient to open valve M and the fuel displaced by the pump piston is by-passed through a valve in the piston itself.

"Take-off" Mixture Strength

When the pilot's throttle is put through the " gate " to the " take-off " position, it is necessary to enrich the mixture strength to counteract the detonation that would accompany the raised boost pressure. Connected to the pilot's throttle lever is the plunger P, which under " take-off " conditions is pressed downwards. This pushes one of the fuel valves E off its seat and in this way allows the necessary extra fuel to enter the air stream *viâ* the diffuser nozzle G. The movement of the plunger P is adjustable and ranges from one extreme, where it is inoperative, to a maximum depression of right-hand valve E of 30 to 40 thousandths of an inch.

Heating

A hot water jacket is formed round the diffuser chambers to minimise the risk of freezing, the water being drawn from the top of the carburetter and taken to the suction side of the water pump. To avoid deposition of fuel in the supercharger casing, a venturi drain is fitted and can be seen in Fig. 5, marked V.

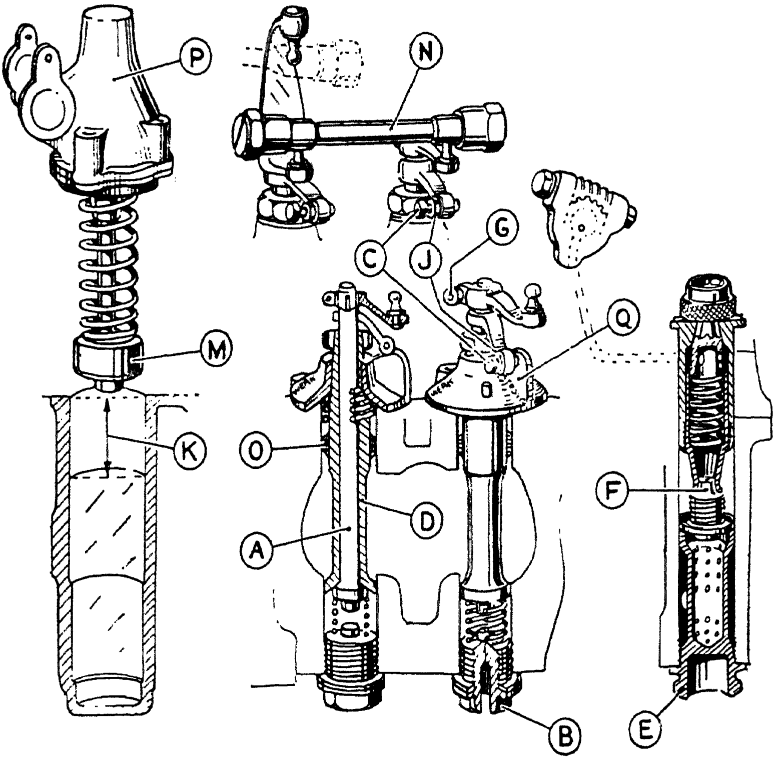


Fig. 3.—ACCELERATOR PUMP, FUEL LEVEL, MIXTURE CONTROLS AND SLOW-RUNNING ADJUSTMENTS.

Dismantling for Cleaning

The following parts should be removed (see Figs. 3 and 5) :—

1. Main air bleed tubes and nozzles with chokes (downwards).
2. Unscrew plug B at the base, remove top controls and main metering valves A (see Fig. 3).
3. Unscrew slow running filter E and the jet F.
4. Remove accelerating pump M and needle valve.
5. Remove float C and the pivots H (see Fig. 5).
6. Remove glands O (Fig. 4) and seating D (see Fig. 3). Thoroughly blow out and clean all passages.

Check float spindle for end play and wear, also see that the metering valve seats are free from abrasion and are quite fuel-tight. Examine the float cut-off contacts and carefully polish the face of the needle valve (see Fig. 5).

See that every part is scrupulously clean, reassemble the parts in the same order and make the following tests. Failing the usual type of level

CARBURETTER SETTINGS

Kestrel Engines :— Series.	B to B3.	MS2.	S3 to S5.	IV to VI.	VII to IX.	X to XII.	XIV to XVI.
Main jet, full strong, under 2 ft. head, pts./hr. . .	43·5	65·0	65·0	68·0	68·0	43·5	100·0
Percentage range to full weak . .	52·0	42·0	42·0	67·0	67·0	52·0	60·0
No. of main jets per engine . .	4·0	2·0	2·0	2·0	2·0	4·0	2·0
No. of pilot jets per engine . .	4·0	2·0	2·0	1·0	1·0	4·0	1·0
Pilot jet calibration, c.c./min. .	155·0	120·0	120·0	400·0	350·0	155·0	400·0
Fuel level under 12 ft. head .	0·875	0·825	0·825	0·475	0·475	0·875	0·475
Fuel level under 2 ft. head . .	1·075	1·225	1·225	—	0·700	1·075	0·700
Enrichment depression full rate .	—	—	0·040	0·040	0·040	—	0·040
Enrichment depression de rate .	—	—	—	0·015	0·015	—	0·015
Working heads, ft.—max. . . .	12·0	12·0	12·0	12·0	12·0	12·0	12·0
Working heads, ft.—min.. . . .	2·0	2·0	2·0	—	2·0	2·0	2·0

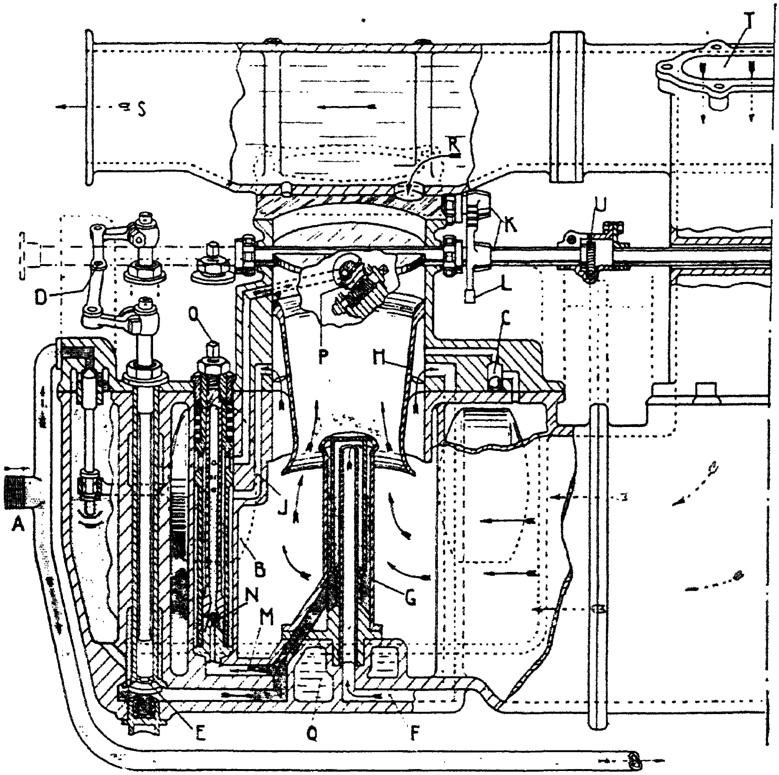


Fig. 4.—DIAGRAMMATIC SECTION OF CARBURETTERS FOR NORMALLY ASPIRATED ENGINES.

A.	Fuel Inlet.
B.	Float.
C.	Float Chamber Air Vent and Ball Valve for Inverted Flying.
D.	Mixture (Main Jet) Control.
E.	Eccentric Varying Main Jet Flow.
F.	Air Bleed to Main Diffuser.
G.	Main Diffuser Nozzle.
H.	Choke.
J.	Air Supply for Slow-running Device.
K.	Main Throttle Shafts Coupled by Quadrant.
L.	Throttle Stop Lever.
M.	Fuel Supply to Slow-running Jet.
N.	Slow-running Jet.
O.	Slow-running Mixture Adjustment.
P.	Slow-running Adjustment Plug.
Q.	Hot Water Jacket.
R.	Supply to Water Jacket.
S.	Main Water Outlet Pipe.
T.	Air Intake.
U.	Worm Adjustment for Synchronising Front and Rear Throttles.

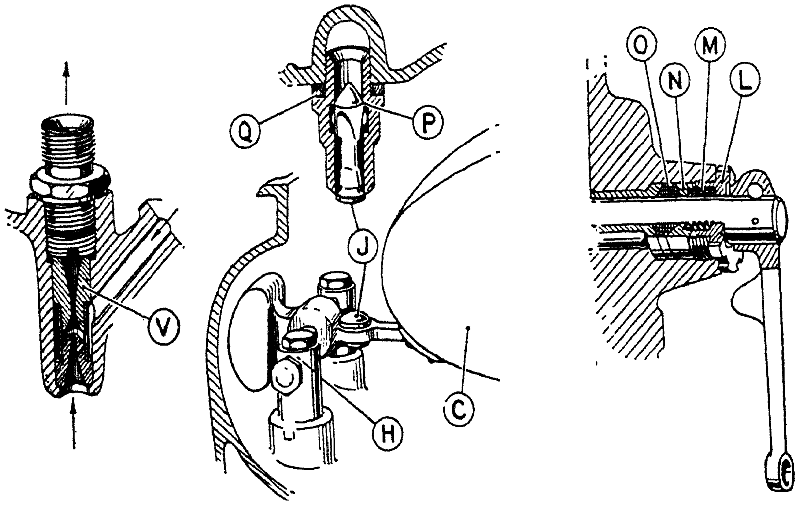


Fig. 5.—SECTIONS THROUGH VOLUTE DRAIN VENTURI, FLOAT NEEDLE VALVE, COUNTERWEIGHTS AND THROTTLE GLAND.

test apparatus, bolt the carburetter to the engine and connect up the main gravity fuel feed. Check that the float mechanism shuts off properly and that the fuel level does not creep.

The Flow Test

The next process is to reset the metering valves so that they give the correct flow and is as follows. See that the pinch bolts G are slack and that the accelerating pump cover is not in position. The flow test should then be made.

1. Replace the plug and spring below the left-hand valve.
2. Insert a special drilled plug and a spring below the *right-hand* valve. The spring is necessary to keep the valve on its seat.
3. Turn on the fuel supply and when a steady flow is obtained, vary the rotational adjustment of the valve until 1 pint of fuel flows in 36 seconds, a suitable measuring vessel being used. This setting is the "Full Rich" position, and must be limited by the stop screws C, which must be locked by the nuts J.
4. Turn the valve to the "Weak" position and recheck the flow. This should be 1 pint in 90 seconds.

The Rolls-Royce carburetter is a precision made instrument and must be handled and adjusted with the care that all precision instruments warrant, and above all scrupulous cleanliness must be observed.

THE "DRAGON RAPIDE"

(TYPE D.H. 89)

By A. J. Brant, *Service Manager, de Havilland Aircraft Co. Ltd.*

THE "Dragon Rapide" type D.H. 89 aeroplane, sometimes referred to as the "Dragon Six" is a two-engined rigidly braced biplane with a wing plan of pronounced taper.

Its weight, dimensions and useful data are given later, the cabin can be arranged to accommodate six to ten passengers in varying degrees of comfort. The cabin and aeroplane generally is of course easily adaptable for many other purposes.

The engines fitted as standard are two "Gipsy Six" Series I Aero Engines, and are also manufactured by the de Havilland Aircraft Co. Ltd., and these are dealt with in another section.

The following data will give good knowledge of the size, performance and chief characteristics of this aeroplane.

Dimensions

Span of wing	48 ft. 0 in.
Height overall	10 ft. 3 in.
Length overall	34 ft. 6 in.
Wheel track	11 ft. 6 in.
Engine centres	11 ft. 6 in.
Mean chord	3 ft. 10·6 in
Incidence	3 deg.
Dihedral	3 deg.

Areas

Main planes with ailerons	340 sq. ft.
Main planes with ailerons and body centre section	366 ,,
Ailerons, total	29·2 ,,
Tail plane	19·53 ,,
Elevators, two	17·4 ,,
Fin	9·7 ,,
Rudder	16·5 ,,

Weights

Note. Aeroplane number 6309, 6315, 6316, 6317, 6321 and sequent will have a Certificate of Airworthiness for an increased All-up Weight of 5,500 lbs. (on earlier aeroplanes 5,200 lbs.).

Certain earlier aeroplanes in addition to the above are being modified to permit the increased All-up Weight to 5,500 lbs.

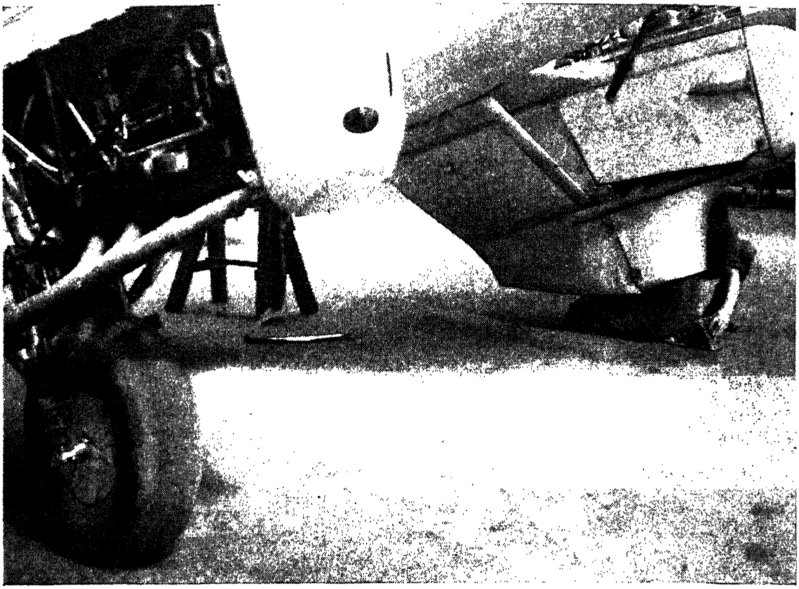


Fig. 1.—PORTABLE JACKING SCHEME FOR WHEEL CHANGING (1).
Chocking the wheel opposite to the side to be lifted.

An examination of the log book and the Certificate of Airworthiness of the individual aeroplanes will determine if this work has been undertaken.

	On 5,200 lbs.	On 5,500 lbs.
Tare weight of aeroplane before fitting passenger furniture, but otherwise in standard condition for operation	3,100 lbs.	3,100 lbs.
Weights of the following are included :		
(1) Bonding and screening	6 ,,	6 ,,
(2) Engine starters	56 ,,	56 ,,
(3) Navigation and other lighting . . .	12 ,,	12 ,,
(4) Landing lights or equivalent . . .	5 ,,	5 ,,
(5) Battery for all purposes	34 ,,	34 ,,

NOTE. The omission of any of the above items permits a corresponding increase in the disposable load.

Disposable Load	2,100 lbs.	2,400 lbs.
Weight of crew	170 ,,	170 ,,
Weight of fuel (standard capacity 76 gallons)	585 ,, *	585 ,, †
Weight of oil (standard capacity 7 gallons)	68 ,, *	68 ,, †

* The fuel and oil shown gives a range of 578 miles. Any reduction in fuel carried may be utilised by equivalent increase in Pay Load.

† The fuel and oil shown gives a range of 573 miles. Any reduction in fuel carried may be utilised by equivalent increase in Pay Load.

Balance available for:	On 5,200 lbs.	On 5,500 lbs.
Cabin furniture and Lavatory (according to scheme selected) average weight 140–150 lbs.	1,277 lbs.	1,577 lbs.
Wireless equipment		
Extra fuel if required		
Pay load		
Maximum permissible weight fully laden	5,200	5,500

NOTE. On 5,200 lbs.

The fitting of metal airscrews increases the tare weight to 3,143 lbs. with a corresponding reduction of the disposable load and pay load to 2,087 lbs. and 1,234 lbs. respectively.

On 5,500 lbs.

The fitting of metal airscrews increases the tare weight to 3,143 lbs. with a corresponding reduction of the disposable load and pay load to 2,357 lbs. and 1,534 lbs. respectively.

Performance

With Schwarz finish or Fairey-Reed airscrews and full navigational and night flying equipment.

NOTE. All performance figures quoted are based on the most accurate possible tests carried out in England and reduced to International Standard Atmospheric Conditions. It must be borne in mind that local conditions of temperature, humidity and barometric pressure have an important influence on aeroplane performance.

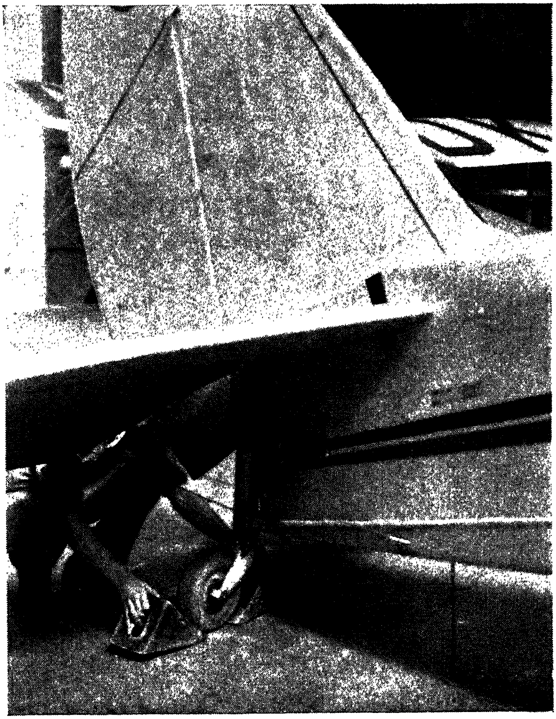
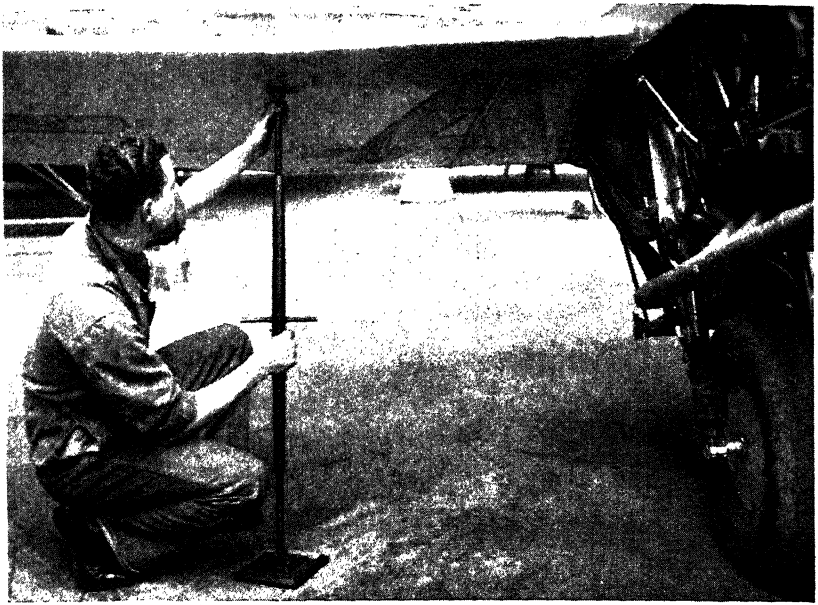


Fig. 2.—PORTABLE JACKING SCHEME FOR WHEEL CHANGING (2). Showing tail wheel swivelled side on ready for chocking.



. 3.—PORTABLE JACKING SCHEME FOR WHEEL CHANGING (3).
Showing the portable pin jointed lifting strut.

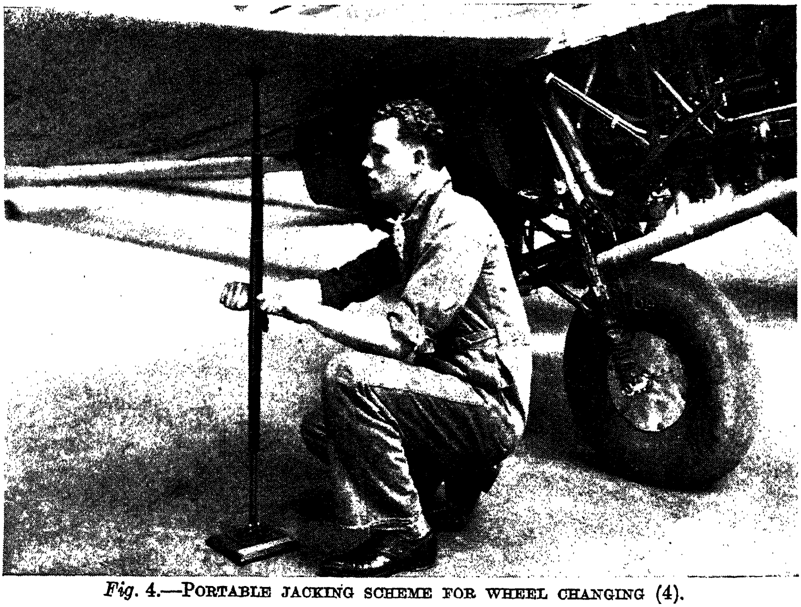


Fig. 4.—PORTABLE JACKING SCHEME FOR WHEEL CHANGING (4).
Lifting with the portable jack.

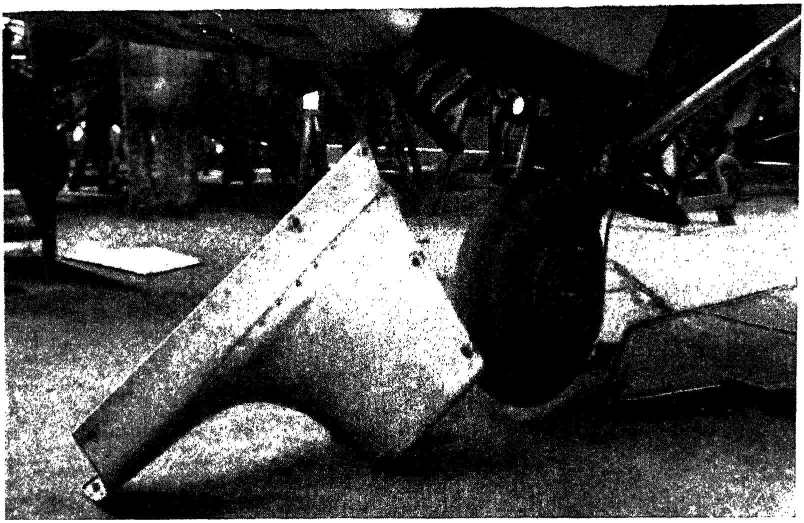


Fig. 5.—REMOVING A WHEEL (1).
The wheel fairings are first removed.

	On 5,200 lbs.	On 5,500 lbs.
Maximum speed at sea level	157 m.p.h.	156·5 m.p.h.
Cruising speed (85 per cent. top speed)	133 m.p.h.	132 m.p.h.
Run to take-off	250 ± 30 yds.	285 ± 30 yds.
Landing run	230 ± 30 yds.	243 ± 30 yds.
Cruising range	578 miles	573 miles.
Rate of climb at sea level	950 ft./min.	867 ft./min.
Time to climb to 5,000 ft.	6¼ mins.	6¾ mins.
,, ,, 10,000 ,,	15 ,,	17 ,,
Ceiling	20,000 ft.	18,850 ft.
Ceiling with one engine stopped	4,500 ft.	3,100 ft.
Fuel consumption at cruising speed	17·5 gls./hr.	17·5 gls./hr.

Weights and Performance Figures

It will be appreciated that the accuracy of performance and weight statements cannot be guaranteed for any indefinite period owing to the developments that occur during the production life of an aeroplane. Improvements introduced, new features added and small alterations made to facilitate maintenance have an effect on weight, while the equipment of an individual aeroplane may affect its performance within small limits. The figures quoted in this publication should be regarded, therefore, as the most accurate estimate it is possible to make and used as a guide only.

Construction of the "Dragon Rapide"

The Dragon Rapide is a two-bay biplane construction with two engines,

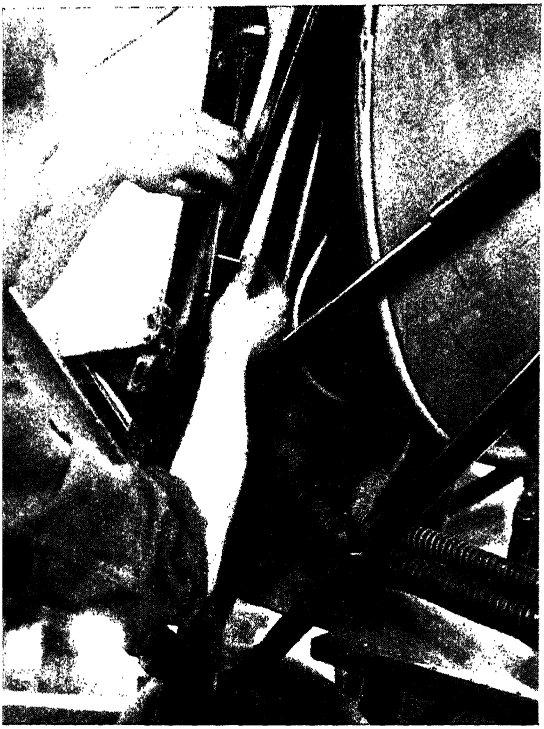
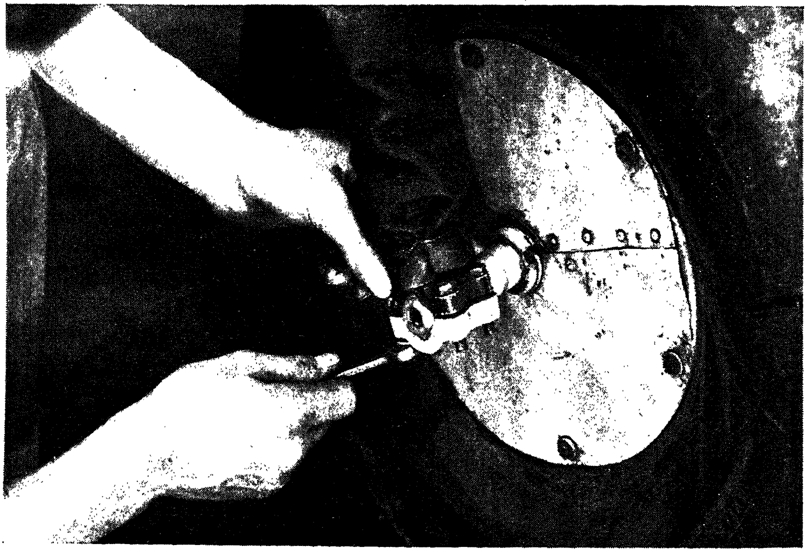


Fig. 6 (*left*).—REMOVING A WHEEL (2).

Next disconnect the brake cable.

Fig. 7 (*below*).—REMOVING A WHEEL (3).

Next remove the axle caps by unscrewing the axle cap nuts.



one on either side of the fuselage mounted on the bottom stub planes.

Each main plane extension consists of I-section spruce spars and spruce ribs of lattice construction, with spruce leading and trailing edges. The leading edge and tips of the planes are ply-covered and ply stiffening is arranged in the region of the interplane strut joints. The internal drag struts are of steel tube, the lugs for the swaged rod and high tensile steel wire bracing being integral with the tube, making a structure which is not affected by any slight shrinkage which might take place in the wooden spars. The interplane struts are of streamline steel construction.

Fig. 8.—REMOVING A WHEEL (4).

Showing the wheel removed and rolled clear of the undercarriage legs.

The stub planes are of steel and wood construction, the front spar being tubular steel reinforced with sleeves and the rear spar of I-section spruce. The engine bay structure aft of the fireproof bulkhead is of welded construction integral with the front spar and bolted to the rear spar. The engine structure side frames forward of the fireproof bulkhead are of welded steel construction and are bolted in position. The fuel and oil tanks are arranged integrally with the stub planes.

The structure of the planes is streamline wire braced, except for the portion between the engine mounting and the fuselage, at which point the load is taken from each spar by tubular streamline struts. These struts also take the undercarriage loads on landing.

Tail Unit

The tail plane consists of spruce spars covered with 3-ply and stiffened

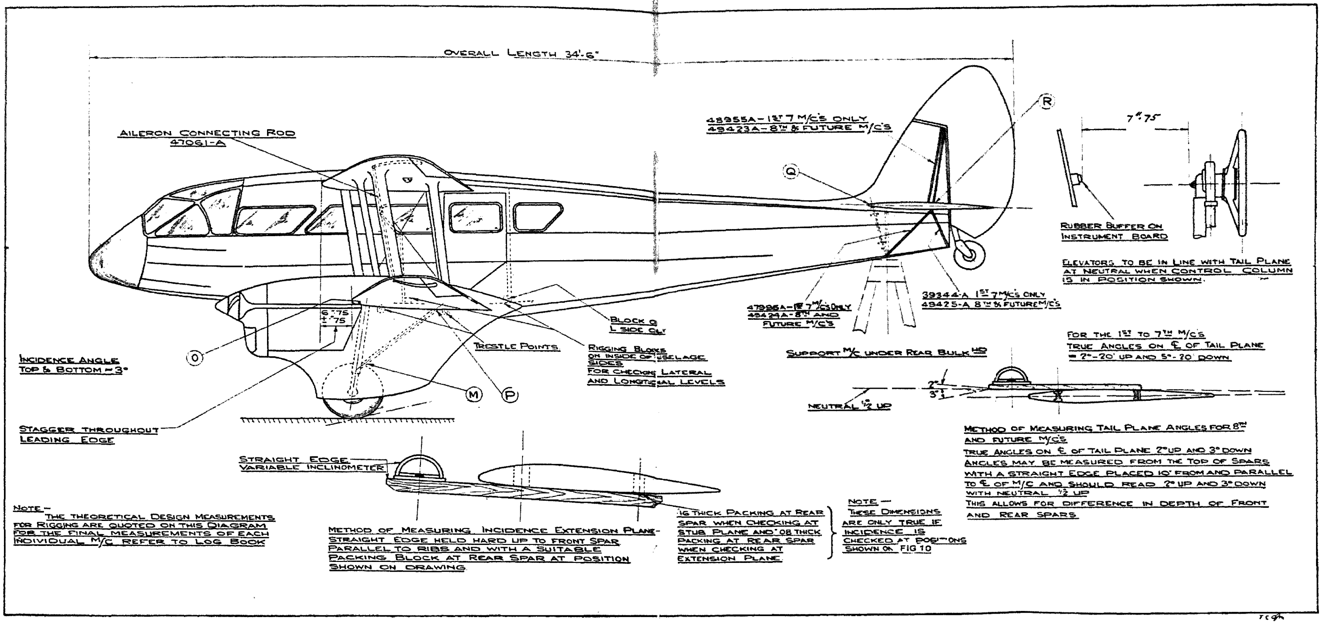

OVERALL LENGTH 34'-6"
AILERON CONNECTING ROD 47061-A
48955A-1ST 7 M/C'S ONLY
49423A-8TH & FUTURE M/C'S
Ⓡ
Ⓠ
7"·75
RUBBER BUFFER ON INSTRUMENT BOARD
ELEVATORS TO BE IN LINE WITH TAIL PLANE AT NEUTRAL WHEN CONTROL COLUMN IS IN POSITION SHOWN.
6"·75
+·75
Ⓞ
INCIDENCE ANGLE TOP & BOTTOM = 3°
TRESTLE POINTS
BLOCK Q L SIDE ONLY
RIGGING BLOCKS ON INSIDE OF FUSELAGE SIDES FOR CHECKING LATERAL AND LONGITUDINAL LEVELS
47996A-1ST 7 M/C'S ONLY
49424A-8TH AND FUTURE M/C'S
39344-A 1ST 7 M/C'S ONLY
49425-A 8TH & FUTURE M/C'S
SUPPORT M/C UNDER REAR BULK HD
Ⓜ
Ⓟ
FOR THE 1ST TO 7TH M/C'S TRUE ANGLES ON ℄ OF TAIL PLANE = 2°-20' UP AND 5°-20' DOWN
2°
3°
NEUTRAL ½ UP
STAGGER THROUGHOUT LEADING EDGE
STRAIGHT EDGE
VARIABLE INCLINOMETER
METHOD OF MEASURING TAIL PLANE ANGLES FOR 8TH AND FUTURE M/C'S
TRUE ANGLES ON ℄ OF TAIL PLANE 2° UP AND 3° DOWN
ANGLES MAY BE MEASURED FROM THE TOP OF SPARS WITH A STRAIGHT EDGE PLACED 10' FROM AND PARALLEL TO ℄ OF M/C AND SHOULD READ 2° UP AND 3° DOWN WITH NEUTRAL ½ UP
THIS ALLOWS FOR DIFFERENCE IN DEPTH OF FRONT AND REAR SPARS
NOTE — THE THEORETICAL DESIGN MEASUREMENTS FOR RIGGING ARE QUOTED ON THIS DIAGRAM FOR THE FINAL MEASUREMENTS OF EACH INDIVIDUAL M/C REFER TO LOG BOOK
METHOD OF MEASURING INCIDENCE EXTENSION PLANE - STRAIGHT EDGE HELD HARD UP TO FRONT SPAR PARALLEL TO RIBS AND WITH A SUITABLE PACKING BLOCK AT REAR SPAR AT POSITION SHOWN ON DRAWING
·16 THICK PACKING AT REAR SPAR WHEN CHECKING AT STUB PLANE AND ·08 THICK PACKING AT REAR SPAR WHEN CHECKING AT EXTENSION PLANE
NOTE — THESE DIMENSIONS ARE ONLY TRUE IF INCIDENCE IS CHECKED AT POSITIONS SHOWN ON FIG 10

Fig. 9.—RIGGING DATA, SIDE VIEW.

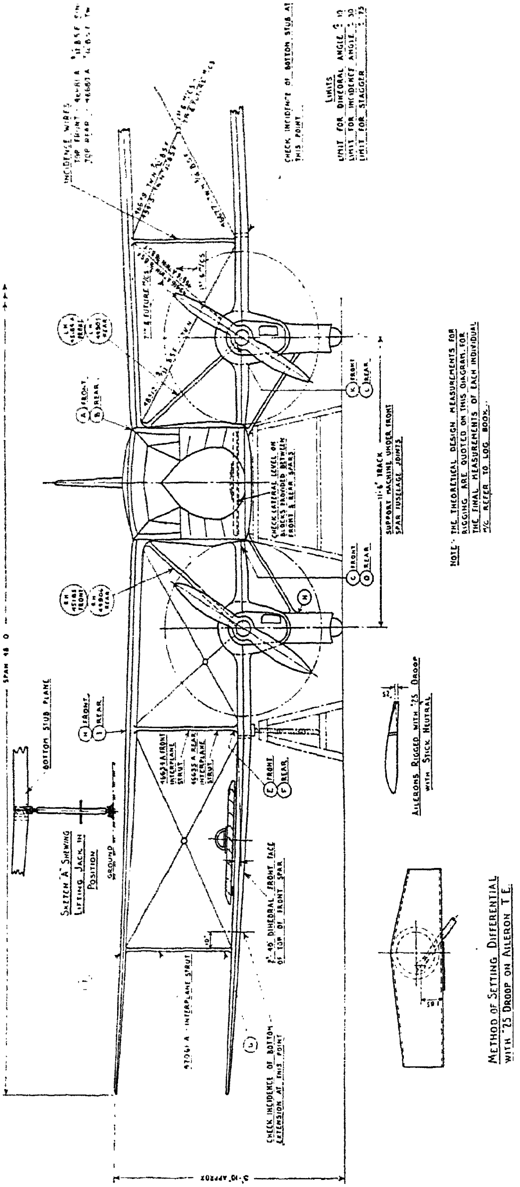
with spruce ribs and formers, the whole being fabric covered strung to the ribs.

The tail plane is hinged at the rear spar and supported at the apex of the front spar by a tube adjustable in length by means of a screw gear capable of being rotated by cables operated by the handwheel in the cockpit. The tail plane is rigidly braced by streamline wires to the top of the fin post and to the bottom of the fuselage.

The elevators comprise spruce spars and braced diagonal ribs, so arranged to take torsional loads. The left and right elevators are coupled together at the centre by a steel fitting which incorporates the control lever.

The rudder is constructed on similar lines as the elevators.

The fin consists of a spruce spar and ribs covered with 3-ply. The 3-ply is covered with a doped fabric, and as both the tail plane and fin depend on the 3-ply skin for their torsional stiffness, it is important that the aeroplane should not be flown with this ply seriously damaged.


SKETCH 'A' SHEWING LIFTING JACK IN POSITION
BOTTOM STUB PLANE
GROUND
SPAN 48' 0"
5'-10" APPROX
CHECK INCIDENCE OF BOTTOM EXTENSION AT THIS POINT
4'10" DIHEDRAL FRONT FACE OF TOP OF FRONT SPAR
INTERPLANE STRUT
INTERPLANE STRUT
INTERPLANE STRUT
AILERONS RIGGED WITH ·25 DROOP WITH STICK NEUTRAL
METHOD OF SETTING DIFFERENTIAL WITH ·25 DROOP ON AILERON T.E.
NOTE: THE THEORETICAL DESIGN MEASUREMENTS FOR RIGGING ARE QUOTED ON THIS DIAGRAM. FOR THE FINAL MEASUREMENTS OF EACH INDIVIDUAL M/C REFER TO LOG BOOK.
11'-6" TRACK
SUPPORT MACHINE UNDER FRONT SPAR FUSELAGE JOINTS
CHECK LATERAL LEVEL ON BLOCKS PROVIDED BETWEEN FRONT & REAR SPARS
LIMITS
LIMIT FOR DIHEDRAL ANGLE
LIMIT FOR INCIDENCE ANGLE
LIMIT FOR STAGGER
CHECK INCIDENCE OF BOTTOM STUB AT THIS POINT
INCIDENCE WIRES
A FRONT
B REAR
C FRONT
D REAR
E FRONT
F REAR
H FRONT
I REAR
K FRONT
L REAR

RIGGING

The tail unit is rigidly attached and the rear fuselage especially strengthened to deal with the torsional loads set up should one engine be out of action.

The longitudinal trim is controlled by a large diameter handwheel which, by means of cables, rotates the screw gear attached to the tail plane front spar. The operating load in the cables has been kept small so as to avoid stretch and subsequent backlash in the mechanism.

Fuselage

The fuselage is constructed of spruce longerons and members covered with 3-ply. An outer covering of fabric, supported by suitable stringers, is fitted. Joint plates are of steel and all fittings taking wing loads are steel forgings.

The bolts at all joints are provided with cupped steel washers, which allow for the natural shrinkage of the timber to take place without the consequent loosening of the bolts.

The compression loads at the wing joints are taken to the fuselage cross members by means of compression studs, which eliminate pressure on the longerons and fuselage members.

Special protective measures are taken the whole structure being protected with a nitro-cellulose finish.

In the standard type the interior of the cabin is treated with fireproof dope. Specially treated upholstery and trimming is used to conform to the Air Ministry regulations, which allow passengers to smoke. The fitment of auxiliary fuel tanks or some other equipment would nullify this permission.

The cabin windows are of transparent flexible sheet.

The cabin is provided with one door and an emergency exit in the roof, also adjustable heating and independent ventilating devices are fitted as standard. A large luggage compartment with independent door is provided at the rear end of the cabin.

The pilot's cockpit at the extreme front of the fuselage affords a particularly good view for flying and landing. The windows are of safety glass and at each side of the cockpit are pivoted safety glass windows, opening for ventilation.

Wheel control of the ailerons is provided, while the elevator control is by fore and aft movement of the control column. The rudder bar is fitted with rudder bias gear, which can be trimmed, and is sufficiently powerful to take care of the turning moment caused when running on one engine. It is important that in the event of adjustment being required to the cables that operate the rudder bias spring, they should *not* be tightened to the point of bringing the end of the spring *behind* the fulcrum of the rudder—otherwise this would tend to swing the rudder to right or left of the central position.

All control cables are carried under the cabin floor, and are protected from weather by a fabric covering provided with large fabric panels, secured with "zip" or hook lace fasteners to allow inspection with the minimum of trouble.

The rear fuselage is provided with holes in the bottom to enable a thorough inspection to be made of the interior.

Engines and Tanks

The mounting for the engine and the fuel and oil tanks consists of an all-metal tubular structure built into the bottom stub plane. A metal and asbestos fireproof bulkhead is fitted between the engine and tanks.

The tanks are slung on cables covered with rubber tubes to damp out vibration.

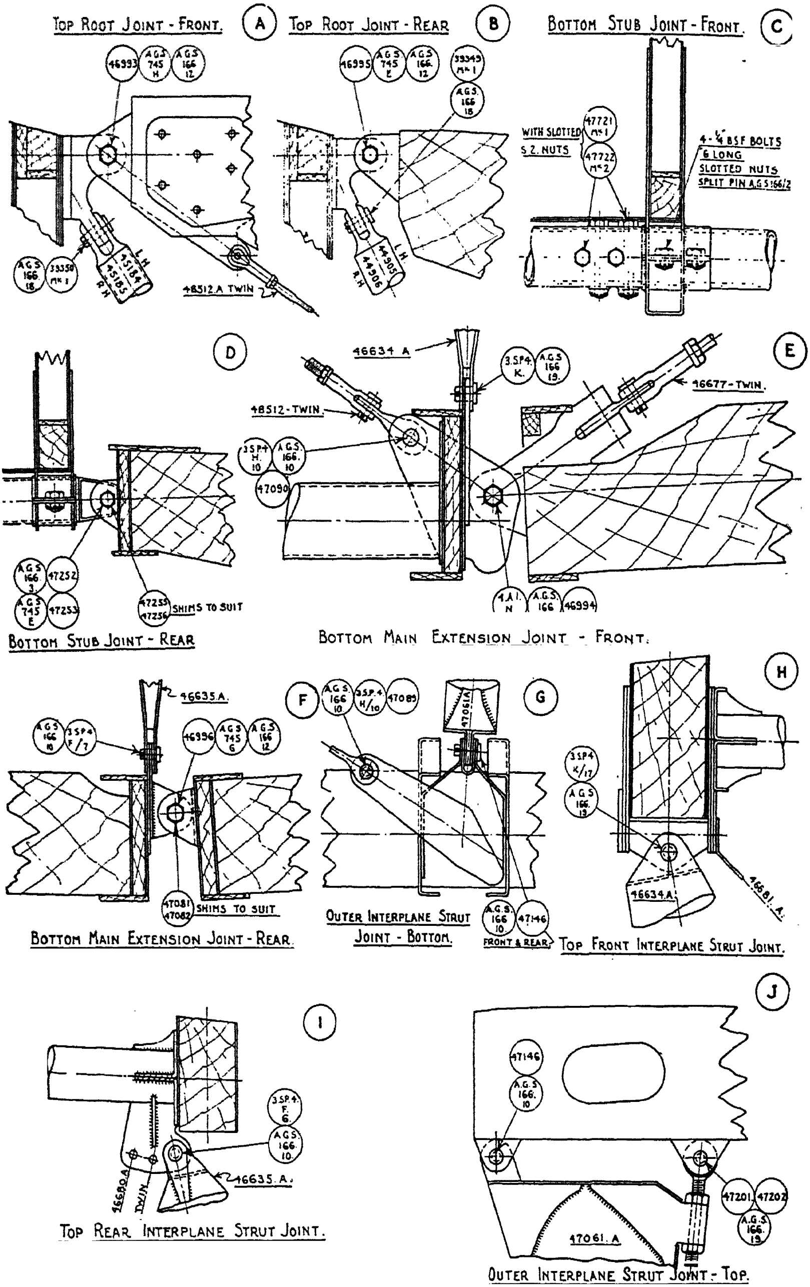


Fig. 11*a*.—RIGGING DATA, JOINTS.

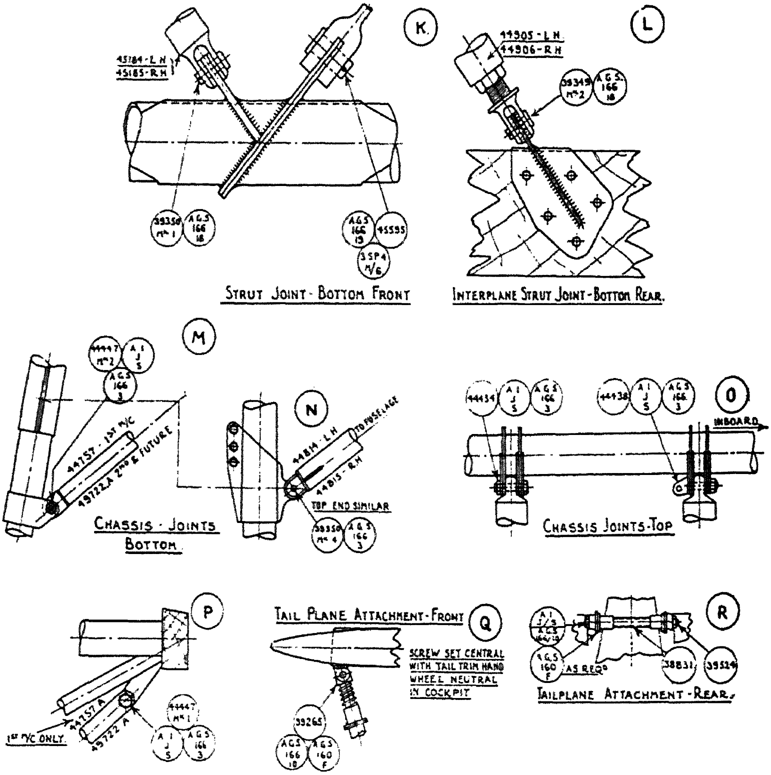


Fig. 11*b*.—RIGGING DATA, JOINTS.

Fuel System

Welded aluminium fuel tanks of 40 gallons capacity are fitted behind each engine, and isolated by means of aluminium and asbestos fireproof bulkheads.

Fuel is supplied by twin engine driven diaphragm pumps on each engine. It is necessary to flood the carburetters. This is done by actuating a lever on the body of the pumps.

Oil System

Oil is supplied from an oil tank fitted behind each engine by means of the engine pump, and passes through a filter before entering the engine. These oil tanks are each of 3½ gallons effective capacity and have a ½ gallon air space above the maximum oil level. They are fitted with dip sticks, on which the bottom marking is arranged to leave 12 pints of oil in reserve. The tanks should never be in use with the oil level below this bottom marking on the dip sticks.

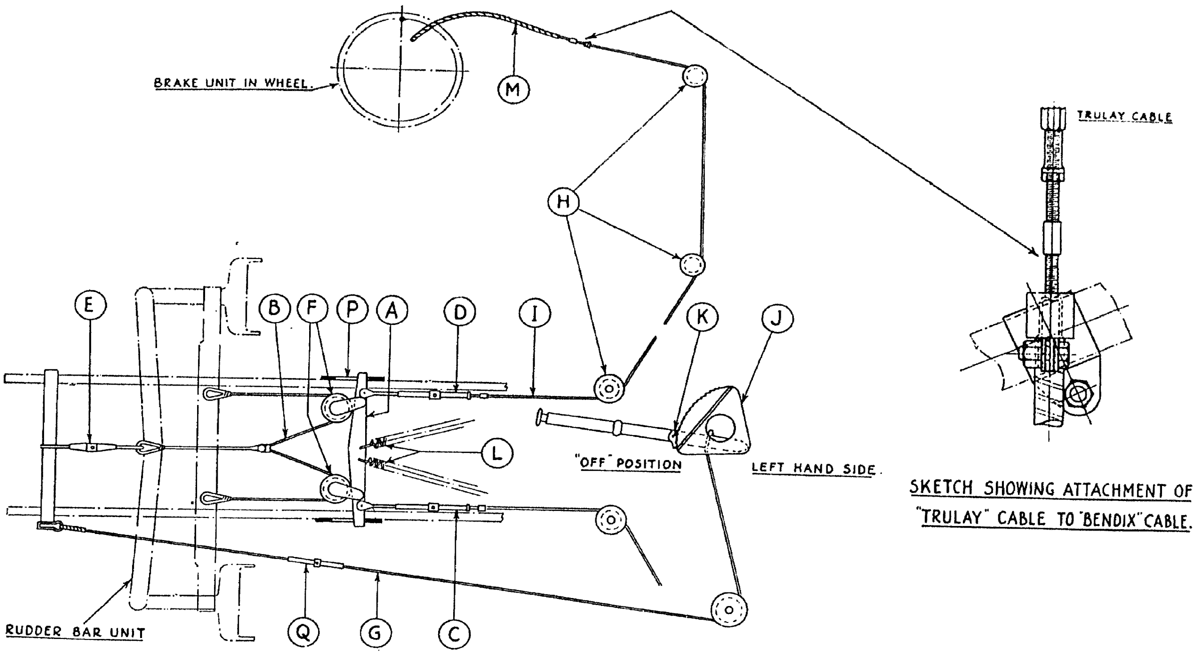


Fig. 12.—BRAKE OPERATING MECHANISM.

A. Compensating Lever.
B. Compensator Cables.
C. Left-hand Cable Adjustment.
D. Right-hand Cable Adjustment.
E. Compensator Adjustment.
F. Compensator Cable Pulleys.
G. Hand Brake Lever Cables.
H. Guide Pulleys.
I. " Trulay " Operating Cable.
J. Hand Brake Unit.
K. Brake Locking Pawl.
L. Return Springs.
M. " Bendix " Cable.
P. Slots in Control Box Sides.
Q. Adjusting Turnbuckle.

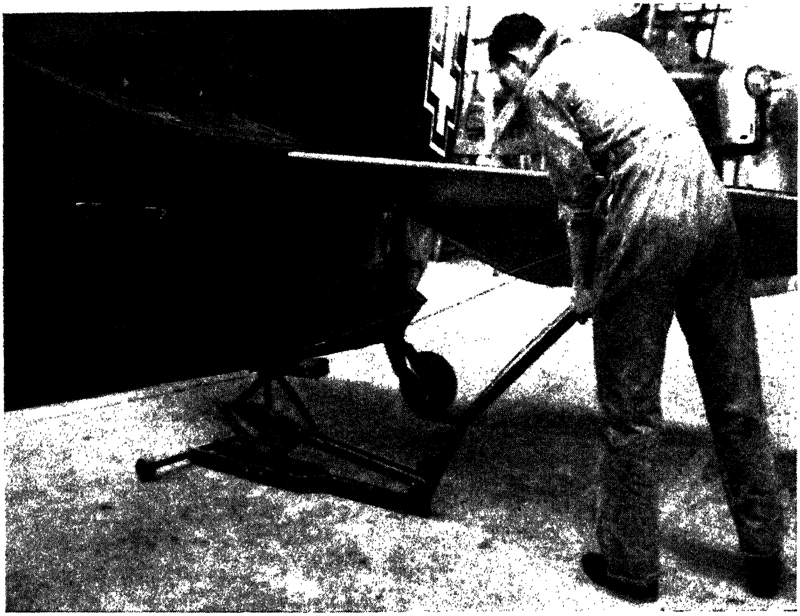


Fig. 13.—REMOVING AND DISMANTLING TAIL WHEEL UNIT (1).
First lift tail wheel clear of the ground.

Undercarriage

The undercarriage is a rigidly braced structure, the only external moving parts being the piston tubes and fittings which slide in the outer casings of the undercarriage legs. There are no hinged joints to move. In consequence, the points where wear might occur have been reduced to a minimum.

Dunlop medium pressure wheels of external size 8·5 in. by 26·5 in. are fitted as standard. The recommended pressure, to be used only when the aeroplane is consistently operated at full load, is 35 lbs. per square inch. When an aeroplane is flown with varying loads from full to light, it is recommended that for a minimum load a tyre pressure of 27 lbs. per square inch be used, and increased proportionately for heavier loads, so as to enhance comfort and ease in landing and taxying. The wheels are encased in streamline fairing, so designed to improve the performance and appearance of the aeroplane in addition to keeping it clean.

Tail Wheel

The tail wheel consists of a high pressure pneumatic wheel with full castor action. The shock absorbing device consists of rubbers in compression encased in telescopic tubes. Particular attention has been paid to provide large bearing surfaces at moving points and lubricators for gun greasing are placed where necessary.

Fig. 14.—Removing and dismantling tail wheel unit (2). Undoing attachment bolts holding unit to fuselage.

The recommended tyre inflation pressure is 50 lbs. per square inch. A hand operated steering lever which attaches to the tail wheel fork can be obtained, to assist in manœuvring the aeroplane on the ground.

RIGGING THE DRAGON RAPIDE

To assemble the aeroplane from the ground up, it is first necessary to support the fuselage on trestles.

Lateral and longitudinal levels can be checked by placing a level on blocks arranged for that purpose inside the cabin on the fuselage side. These blocks, together with the trestle points, are shown on Rigging Diagrams, Figs. 9 and 10.

The bottom stub plane, complete with engine and accessories, should now be fitted to the tubular spars on the underside of the fuselage, using overhead tackle or improvised trestles to take the weight. The joints at the fuselage are secured by bolts and slotted nuts retained by split pins.

The diagonal struts should now be fitted, first removing the ventilator fairing at the top of the fuselage, taking care to select the correct hand, as otherwise they will not point into wind. The chassis struts can now be added.

With the diagonal struts in position the stub plane will be self-supporting, but care should be taken in the interval between fitting up both sides to trestle up assembled parts to avoid tipping the fuselage.

The top plane, while on the ground, can now have the three interplane

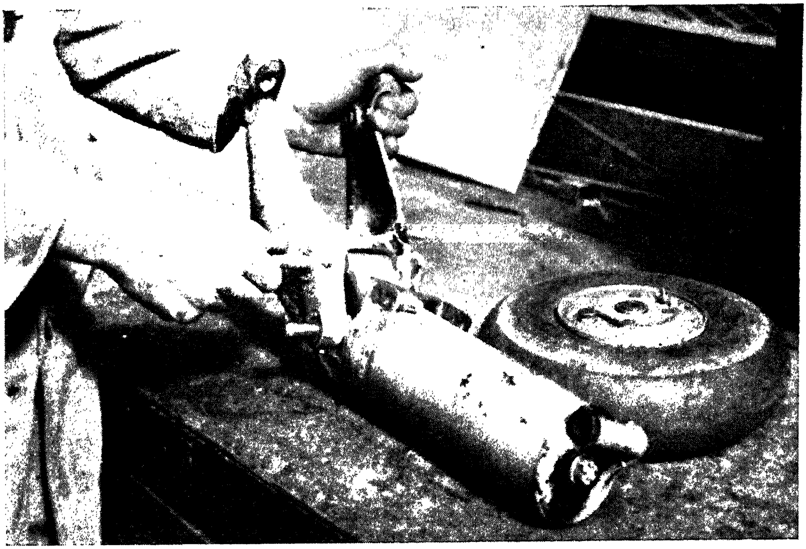


Fig. 15.—REMOVING AND DISMANTLING TAIL WHEEL UNIT (3).
Dismantling the shock absorber unit from the wheel fork.

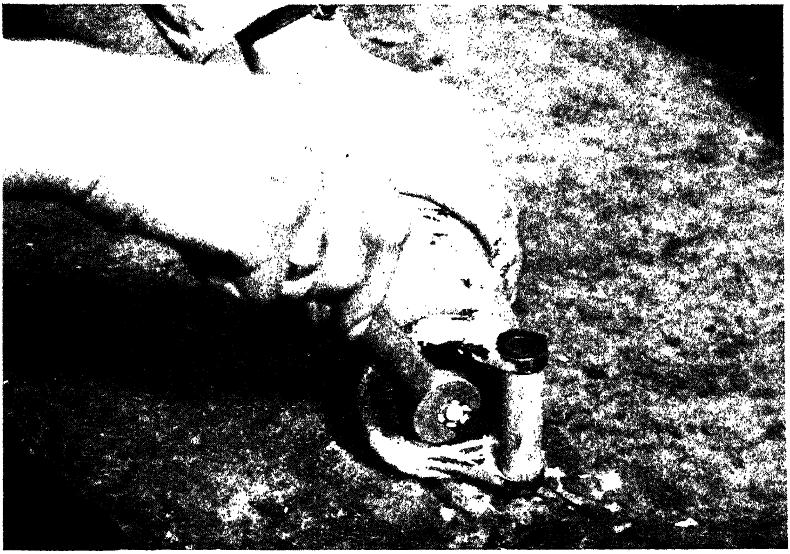


Fig. 16.—REMOVING AND DISMANTLING TAIL WHEEL UNIT (4).
Removing the centre nut.

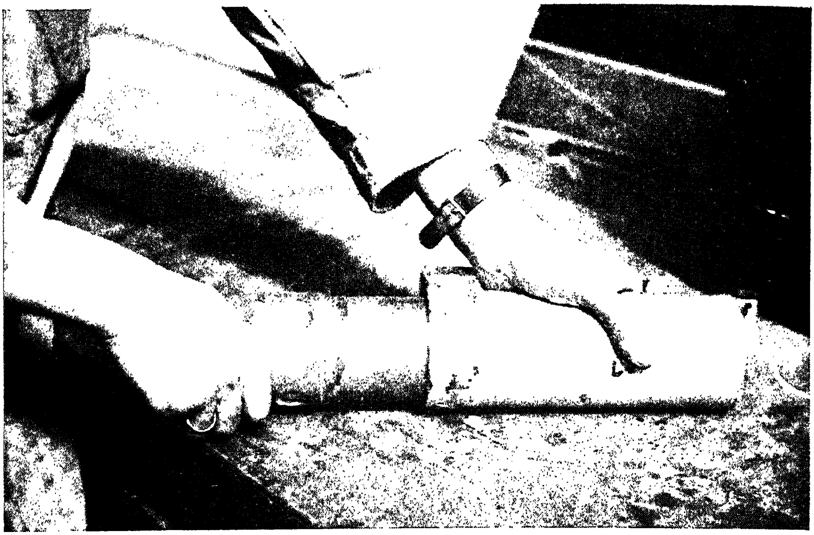


Fig. 17.—REMOVING AND DISMANTLING TAIL WHEEL UNIT (5). Withdrawing inner sub-assembly.

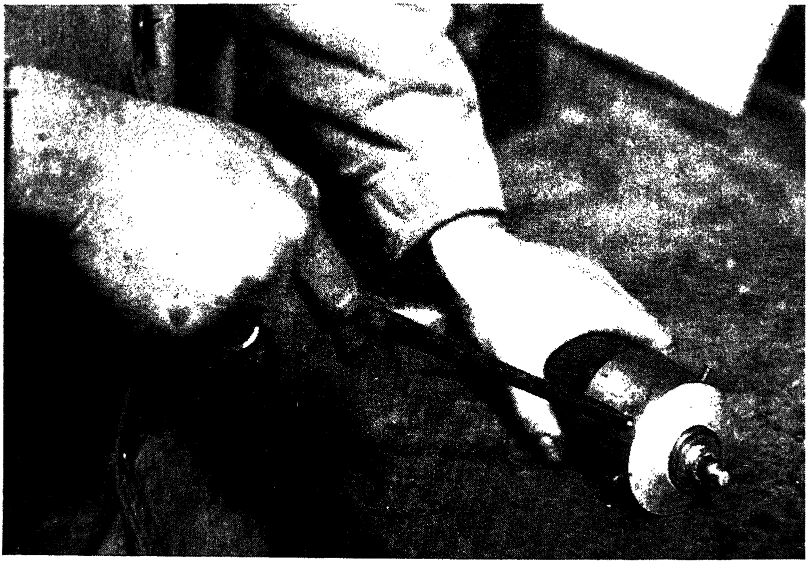


Fig. 18.—REMOVING AND DISMANTLING TAIL WHEEL UNIT (6). Undoing setscrews to enable top inner fitting to be removed.

Fig. 19.—REMOVING AND DISMANTLING TAIL WHEEL UNIT (7).
Unscrewing centre tension rod.

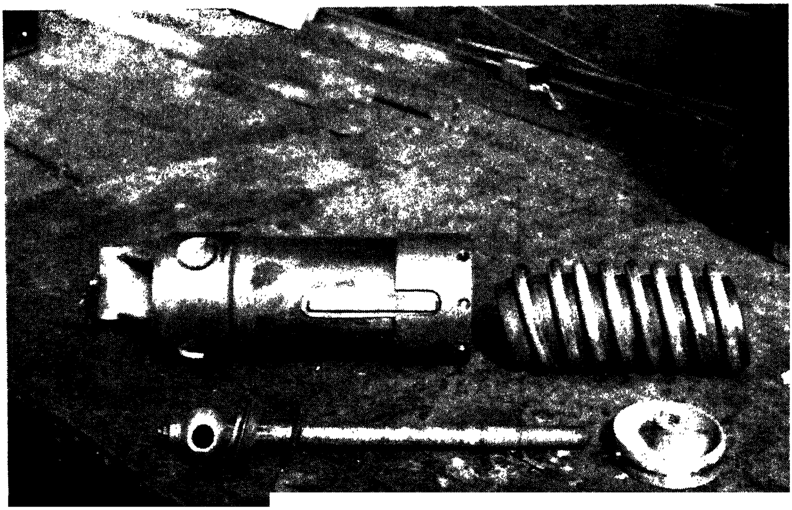


Fig. 20.—REMOVING AND DISMANTLING TAIL WHEEL UNIT (8).
Showing rubbers drawn off.

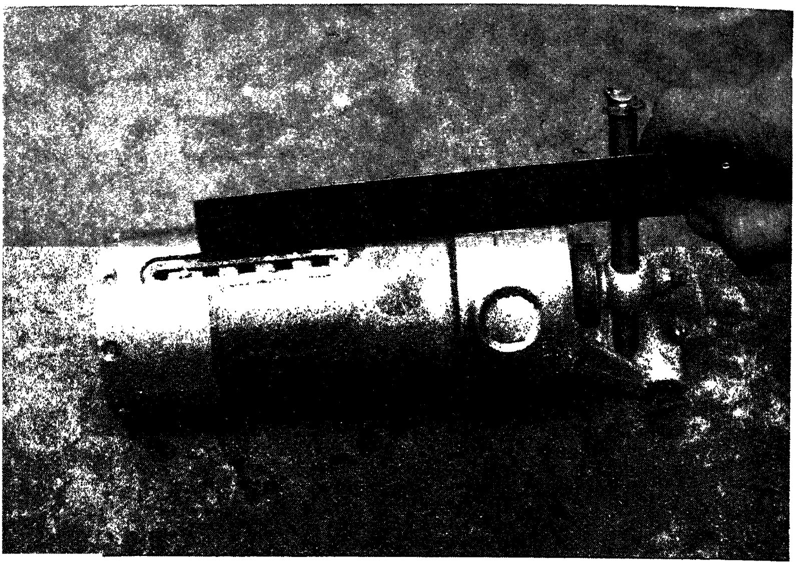


Fig. 21.—REMOVING AND DISMANTLING TAIL WHEEL UNIT (9).

Adjusting tension rod on reassembly. Showing the rubbers back in position and checking length, which should be 7¼ in., with rule.

struts attached and then lifted into position and secured to the top fuselage joints by joint bolts. The centre interplane struts should now be attached to the bottom stub and boxed up, and the incidence wires between the struts screwed up in an approximate position.

The bottom extension plane is next assembled to the stub plane and the joint bolts inserted ; the outer bay strut is then connected and pinned up to the bottom plane and the interplane wires attached.

The top and bottom planes are now in position with the stagger approximately set ; the correct incidence is obtained by adjusting the incidence wires, between the first bay interplane struts, adjusting fork ends with an equal number of turns at each end.

The interplane wires between the two bays can now be adjusted in a similar manner to obtain the true dihedral. The rear diagonal strut, which is adjustable, can now be screwed up.

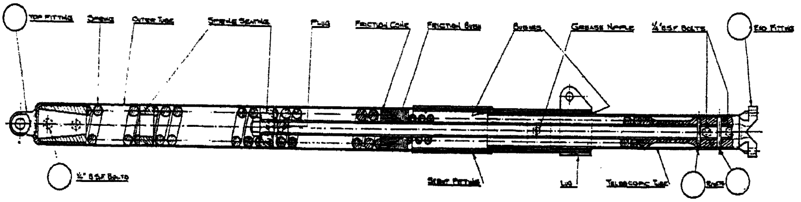


Fig. 21*a*.—SECTION OF UNDERCARRIAGE LEG.

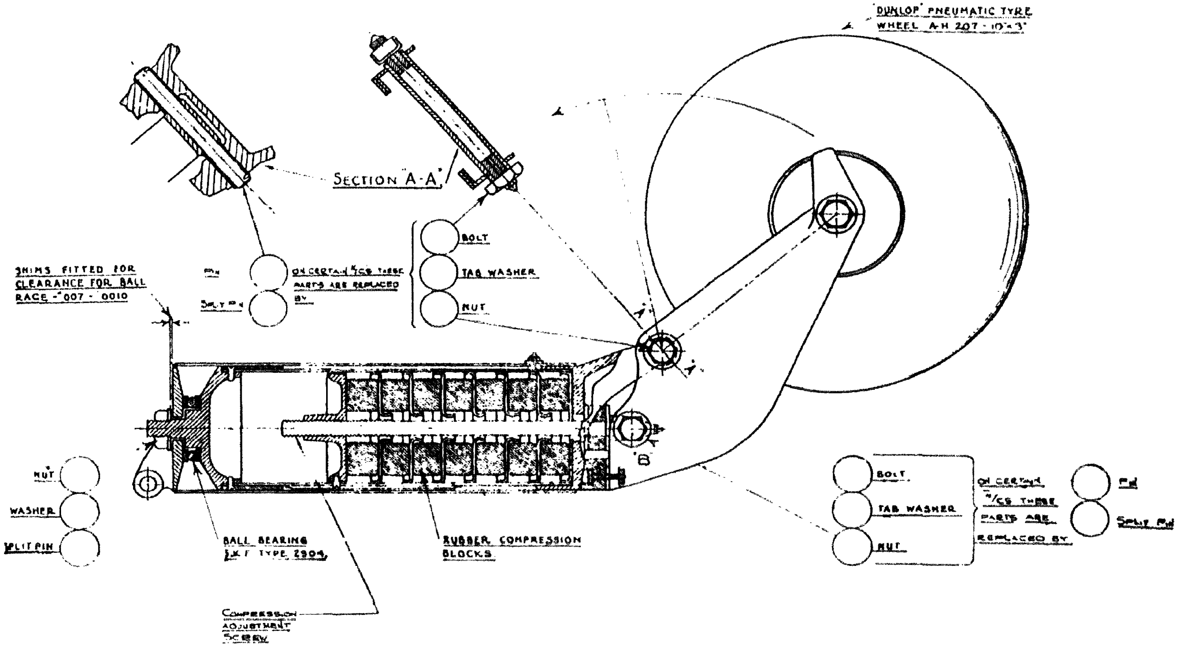

'DUNLOP' PNEUMATIC TYRE
WHEEL A.H 207 - 10"×3"
SECTION 'A-A'
BOLT
TAB WASHER
NUT
ON CERTAIN A/CS THESE PARTS ARE REPLACED BY
PIN
SPLIT PIN
SHIMS FITTED FOR CLEARANCE FOR BALL RACE -·007 - ·0010
A
A
B
BOLT
TAB WASHER
NUT
ON CERTAIN A/CS THESE PARTS ARE REPLACED BY
PIN
SPLIT PIN
NUT
WASHER
SPLIT PIN
BALL BEARING S.K.F TYPE 2904
RUBBER COMPRESSION BLOCKS
COMPRESSION ADJUSTMENT SCREW

Fig. 22.—DETAILS OF TAIL WHEEL.

Note that nine rubbers and spacers are used, and not seven as shown in the diagram.

Note for Adjustment of Compression.

Remove bolt "B" and swing wheel clear in direction of arrow around pivot bolt "A-A," then adjust by screwing central plunger rod.

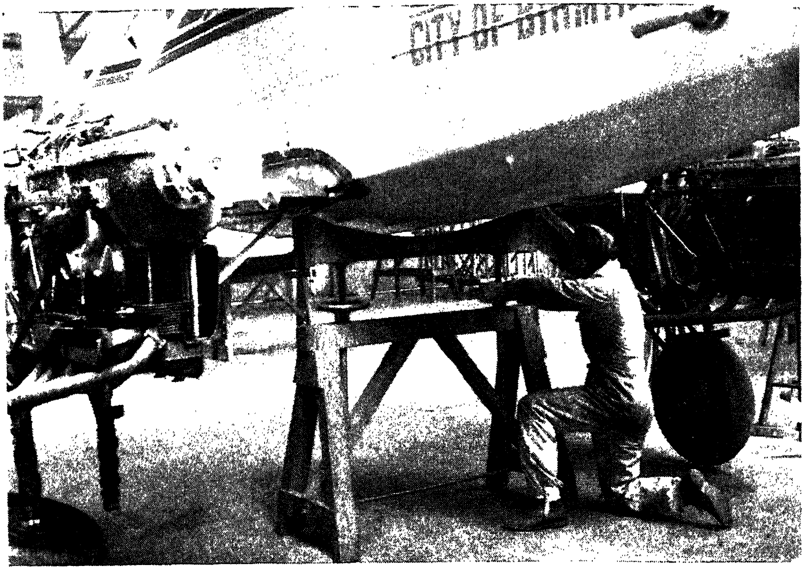


Fig. 23.—TRESTLING THE "DRAGON RAPIDE" (1).
Showing trestling point under front fuselage.

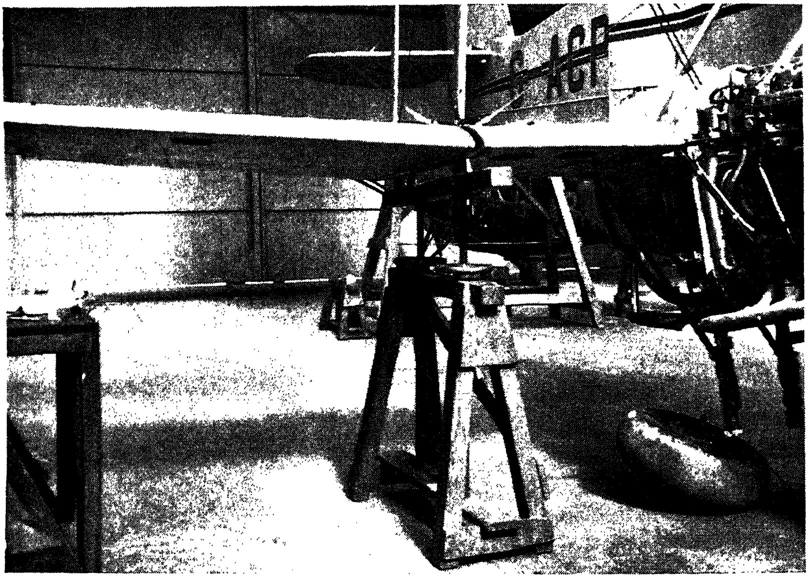


Fig. 24.—TRESTLING THE "DRAGON RAPIDE" (2).
Showing alternative trestling point under stub plane.

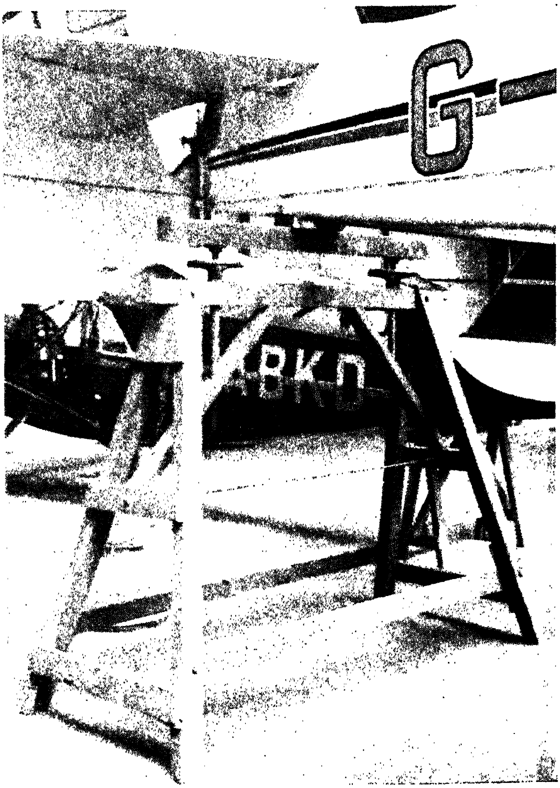


Fig. 25.—TRESTLING THE "DRAGON RAPIDE" (3).
Showing trestle in position under rear fuselage.

The planes on the other side can now be rigged in a similar manner, but care should be taken that all trestles under the rigged plane are quite secure to prevent tipping the aeroplane.

Check the levelling of the fuselage and readjust if necessary, and then proceed with the trueing up.

The rigging diagrams should be consulted for general information, but the actual angles to which a particular aeroplane was passed out by the constructor are given in the Aircraft Log Book, and to these figures it should be rigged. The necessity for this arises as such data as tail plane settings are sometimes altered from standard to deal with special equipment or requirements.

Care should be taken when rigging to ensure that the main flying and landing wires are not over-tensioned to the extent of bowing the main plane spars. It will be appreciated that large wires can be tightened to an excessive degree far in excess of that required to obtain the correct rigging. If any difficulty is experienced, the rigging is probably at fault, and a careful check should be made throughout.

Chassis

The chassis is a rigidly braced structure, so that no adjustments are provided. Fig. 11B shows at *M*, *N*, *O* and *P* the attachment of the compression leg and radius rods to their respective joints. To ensure that the chassis has been correctly assembled, a check measurement can be taken

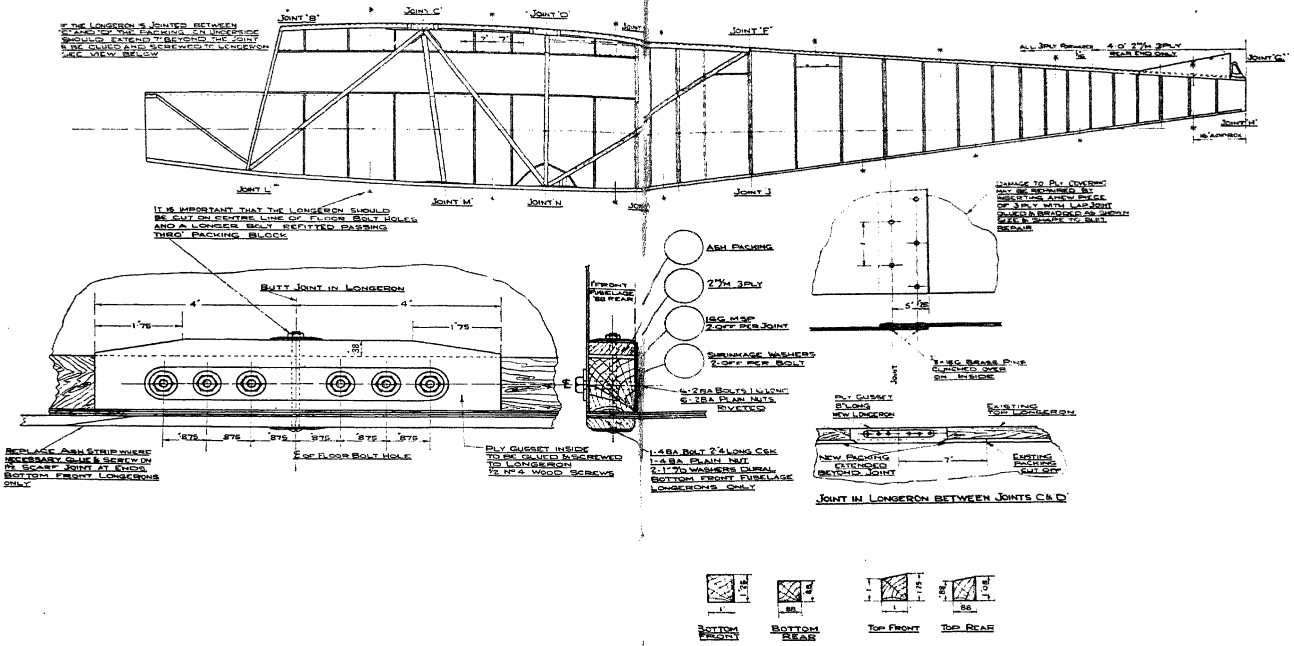
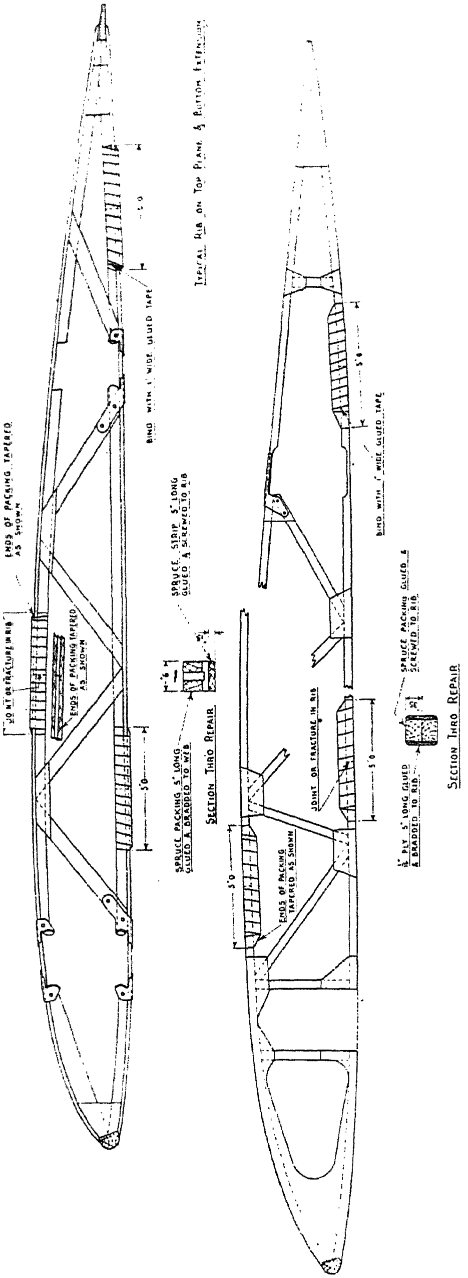

If the longeron is jointed between "C" and "D" the packing on underside should extend 7" beyond the joint & be glued and screwed to longeron see view below
Joint "B"
Joint C
Joint "D"
Joint
7" 7"
Joint "F"
All 3ply forward 4·0" 2m/m 3ply rear end only
1/16
Joint "G"
Joint "H"
16" approx.
Joint L
Joint M
Joint N
Joint
Joint J
It is important that the longeron should be cut on centre line of floor bolt holes and a longer bolt refitted passing thro' packing block
Butt joint in longeron
4"
4"
1·75
1·75
·38
·875
·875
·875
·875
·875
·875
℄ of floor bolt hole
Replace ash strip where necessary glue & screw on 1ft scarf joint at ends. Bottom front longerons only
Ply gusset inside to be glued & screwed to longeron 1/2 No 4 wood screws
1" front fuselage ·88 rear
℄
Ash packing
2m/m 3ply
16G MSP 2-off per joint
Shrinkage washers 2-off per bolt
6-2BA bolts 1·6 long
6-2BA plain nuts riveted
1-4BA bolt 2·4 long csk
1-4BA plain nut
2-1" ⌀ washers dural
Bottom front fuselage longerons only
Damage to ply covering may be repaired by inserting a new piece of 3ply with lap joint glued & bradded as shown size & shape to suit repair
5" 1/25
Joint
1/8 × 18G brass pins clinched over on inside
Ply gusset 8" long
New longeron
Existing top longeron
New packing extended beyond joint
7"
Existing packing cut off
Joint in longeron between joints C & D
1·25
·88
1"
·88
1·25
1"
·88
·88
1·08
·88
Bottom front
Bottom rear
Top front
Top rear

Fig. 26.—Details for Fuselage Repairs.

Important Notes.

Damaged longerons may be cut out between points marked thus * and a new length inserted between any two points jointed as shown in enlarged view. When longerons are damaged, it is also important to inspect the joints, and if the slightest doubt exists as to whether these are sound a new length of longeron should extend through the joint. New lengths of longeron are of spruce to Specification D.T.D. 36A. Joint plates are of 16 G. mild steel plate to Specification S.3. Failing this, the tensile strength should not be less than 26 tons per square inch. Bolts should be mild steel to Specification S.1. Failing this, the tensile strength should not be less than 35 tons per square inch. Three-ply should be $\frac{1}{16}$ in. and 2 mm. as shown. Packing blocks are of good quality ash, glued and screwed to longerons with four 1-in. No. 5 wood screws. All outside faces and edges of 3-ply to be covered with madapolam or low-grade cotton fabric doped on.


TYPICAL RIB ON TOP PLANE & BOTTOM EXTENSION
BIND WITH 1" WIDE GLUED TAPE
5'0"
ENDS OF PACKING TAPERED AS SHOWN
JOINT OR FRACTURE IN RIB
ENDS OF PACKING TAPERED AS SHOWN
SPRUCE STRIP 5" LONG GLUED & SCREWED TO RIB
SPRUCE PACKING 5" LONG GLUED & BRADDED TO WEB
SECTION THRO REPAIR
BIND WITH 1" WIDE GLUED TAPE
JOINT OR FRACTURE IN RIB
ENDS OF PACKING TAPERED AS SHOWN
SPRUCE PACKING GLUED & SCREWED TO RIB
1/8" PLY 5" LONG GLUED & BRADDED TO RIB
SECTION THRO REPAIR

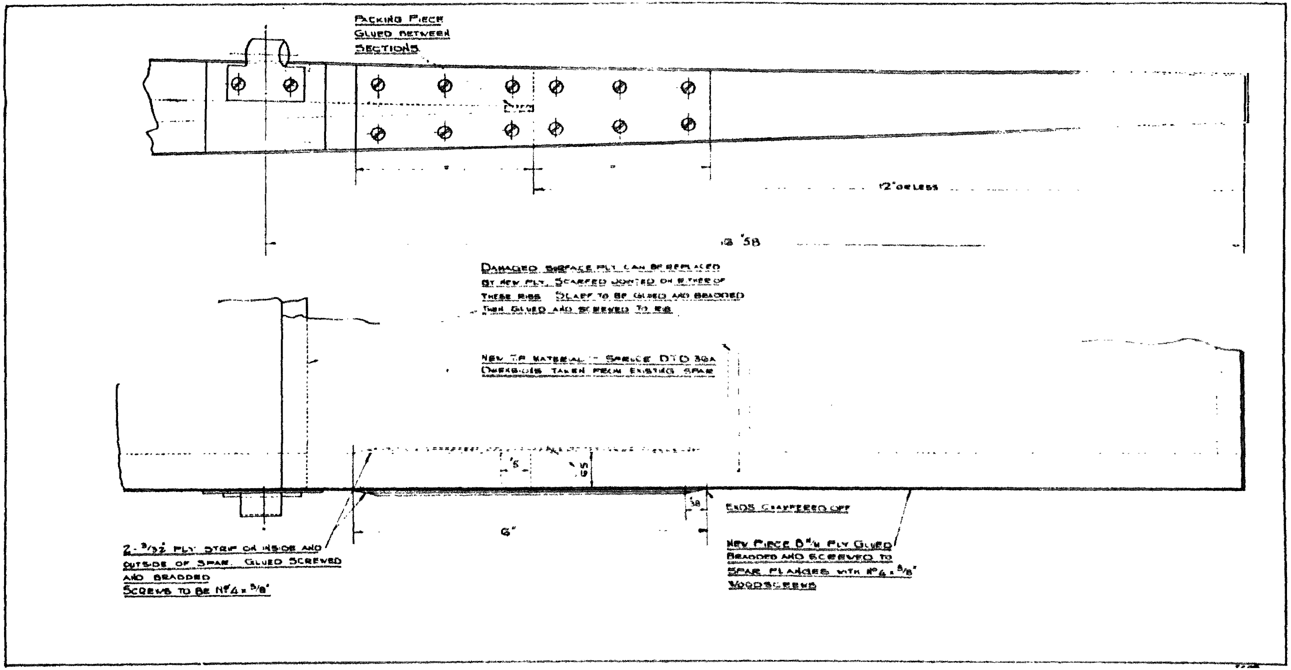
between the tyres—a difference of ¾ in. between the measurements taken fore and aft of the wheel centres is permissible.

Tail Unit

The tail plane is attached to the fuselage at the front spar by the adjustable screw gear as shown at *Q* on Fig. 11B, and at the rear spar by means of a bolt passing through the pivot bracket and clamping on to a distance tube passing through the bearings on the fuselage as shown at *R* on Fig. 11B. Shims in the form of AGS. 160F washers are used between the fuselage bearings and the tail plane pivot brackets to take up side play.

The tail plane should be assembled first to the aeroplane and its control cables joined up. The fin is then bolted to the bracket on the stern post at the forward end to the raised structure at the rear end of the fuselage.

Special care is necessary when carrying out the rigging adjustment to the tail plane to ensure that the tail plane bracing


PACKING PIECE GLUED BETWEEN SECTIONS
12" OR LESS
18 ·58
DAMAGED SURFACE PLY CAN BE REPLACED BY NEW PLY, SCARFED JOINTED ON EITHER OF THESE RIBS. SCARF TO BE GLUED AND BRADDED THEN GLUED AND SCREWED TO RIB
NEW TIP MATERIAL – SPRUCE DTD 36A OVERSIDES TAKEN FROM EXISTING SPAR
·5
·5/16
·38
ENDS CHAMFERED OFF
6"
2-3/32" PLY STRIP ON INSIDE AND OUTSIDE OF SPAR. GLUED SCREWED AND BRADDED
SCREWS TO BE Nº 4 × 5/8"
NEW PIECE 3/32" PLY GLUED BRADDED AND SCREWED TO SPAR FLANGES WITH Nº 4 × 5/8" WOODSCREWS

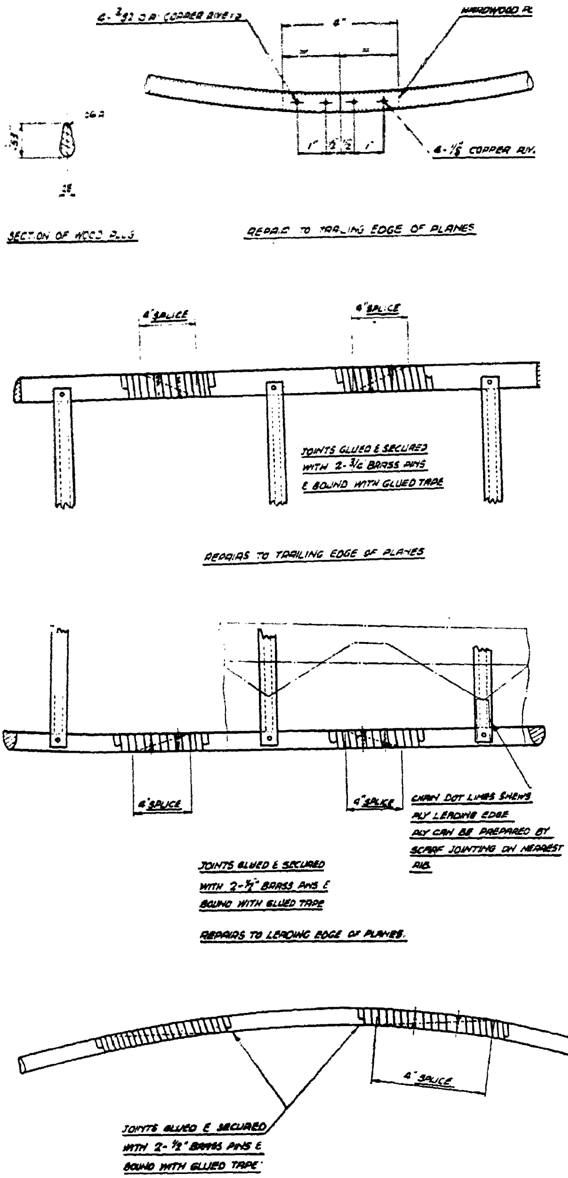


Fig. 29.—REPAIRS TO LEADING AND TRAILING EDGE.

wires will be adequately tensioned for the whole range of the tail plane incidence. In order that this procedure may be carried out, the tail plane should be set in the neutral position, as determined from the indicator adjacent to the tail plane adjuster wheel, and all external bracing wires adjusted to the normal tension. The bottom rear bracing wires are then to be given an extra half turn. Care should also be taken to ensure that the wiring plates on the rear spar of the tail plane taking the external bracing wires are free to swivel on the fixing bolt.

Differential Aileron Control

Should the setting of the differential pulley in the bottom planes be disarranged

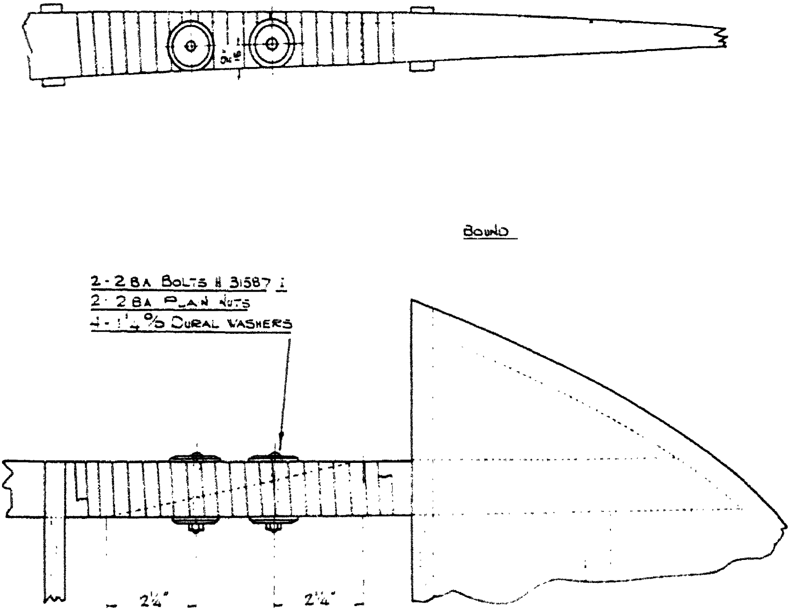


Fig. 30.—REPAIR TO SPAR ENDS.

for any reason, such as the dismantling and reassembly of planes, care must be taken to reassemble as before. This can be conveniently done by means of a steel rule inserted between the two metal drag ribs to read required measurement 1·85 in. (distance between crank and bottom of drag ribs) as shown on Rigging Diagram, Fig. 9. This dimension, 1·85 in., should be read with the control wheel neutral and allowing a droop of approximately ·25 in. at the trailing edge of the ailerons.

The aileron push rod between crank pin and aileron lever is adjustable, but, once set, should not be altered unless for reasons outlined below. (The above remarks appertain to both sides of the airframe.)

If the aeroplane shows a tendency to fly one wing low, first check the rigging of the wing structure and note if differential setting is correct. Should these be found in order the trouble may be due to slight warping of aileron spars.

Rectification should be made in the following manner :—

(*a*) Disconnect both push rods between crank pin on pulley and aileron lever.

(*b*) Lengthen the push rod on the side which tends to fly low by

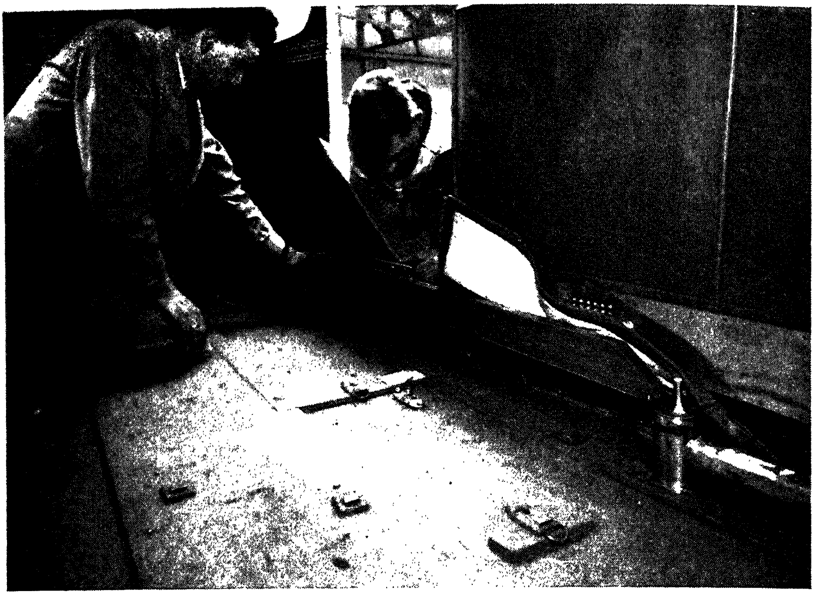


Fig. 31.—LEVELLING LONGITUDINALLY.
With straight edge and level on levelling blocks in

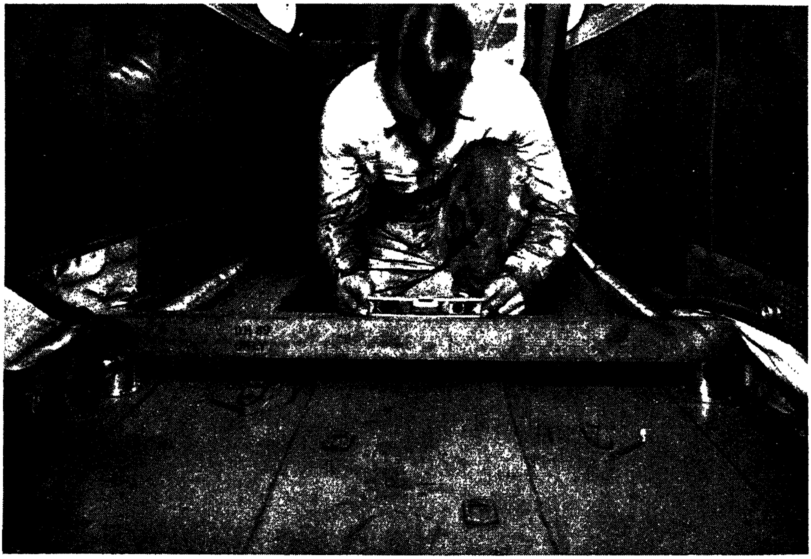


Fig. 32.—LEVELLING LATERALLY.
With straight edge and level on levelling blocks in

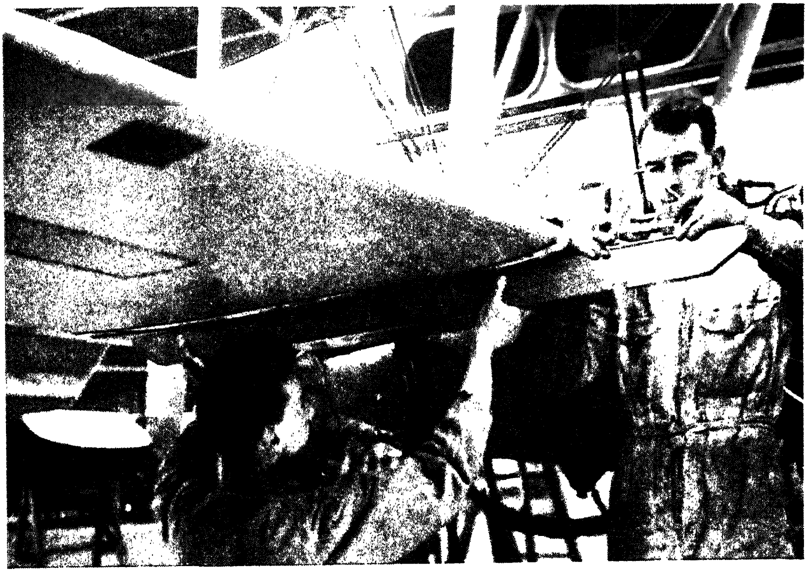


Fig. 33.—CHECKING INCIDENCE AT INNER BAY.

unscrewing the adjustable end by one turn, shortening the rod on the other side by a corresponding amount.

(*c*) Re-connect the push rods.

If this adjustment proves insufficient to correct the trim of the aeroplane the operation should be repeated until the fault is overcome. Care should be taken, however, that it is not attempted to put an incorrectly rigged aeroplane in order by this means. It should never be necessary to shorten or lengthen the adjustable push rods by more than two or, at the most, three turns.

Undercarriage Body Struts

The length of the Dragon Rapide Body Strut up to issue 6 was 40·56 in. Issue 7 and subsequent is 40·0 in.

This modification was made to give more clearance of the leg from the remainder of the structure and it is not considered that interchangeability is affected.

It is quite in order to use an issue 6 strut on one side of an aeroplane and an issue 7 on the other.

Wheel Brake Adjustment

Bendix brakes are fitted as standard to the Dragon Rapide (see Fig. 12). Major adjustment :—

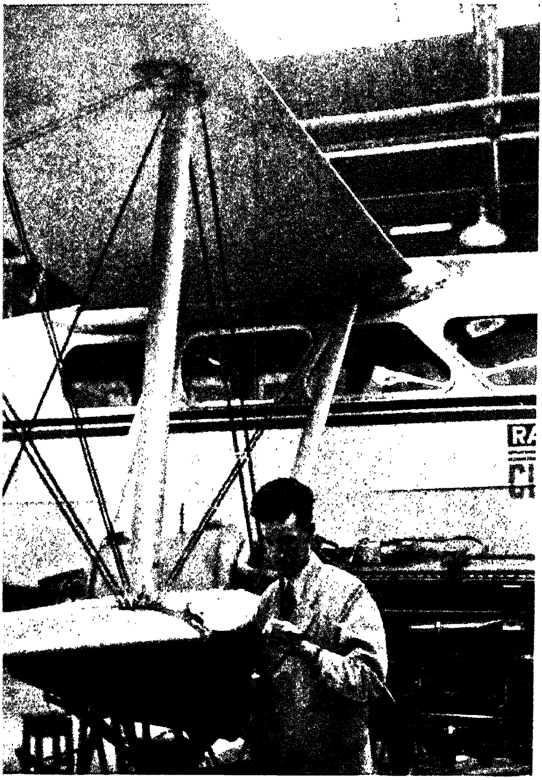


Fig. 34.—CHECKING STAGGER AT INNER BAY.

NOTE. This adjustment is only necessary for initial setting of the operating cables at the works, or if the undercarriage has been dismantled or when new shoes are fitted.

1. Jack up aeroplane and remove wheels.

2. Approximately centralise shoes.

3. The hand brake lever in the "Off" position forms the stop for the compensating bar A. When the hand brake lever is in the "Off" position it should be checked that the compensating bar is just clear of the aft end of the slots P in the control box side. If this is not so, correction can be made by adjusting turnbuckle E. With hand brake lever "off," no movement of the rudder bar is transmitted to the compensating bar, the cables "B" run slack. By pulling the hand brake lever "on" this slackness is taken up and the brakes commence to operate after any desired movement of the rudder bar. If the hand brake lever is pulled full "on" a differential brake action is still possible.

4. With the hand lever in the "off" position, adjust the turnbuckles D, securing the cables I to the ends of the compensating bar so that the operating cam in the brake is just touching the shoes without actually expanding them. The wheel should then be put into place.

5. It should now be ascertained if the brakes are free when the rudder is centralised, and also that the full rudder movement is obtained in both directions. A check measurement taken between the tip of the balanced portion of the rudder and the fin should give not less than 6 in.

Fig. 35.—CHECKING DIHEDRAL ON OUTER BAY FRONT SPAR.

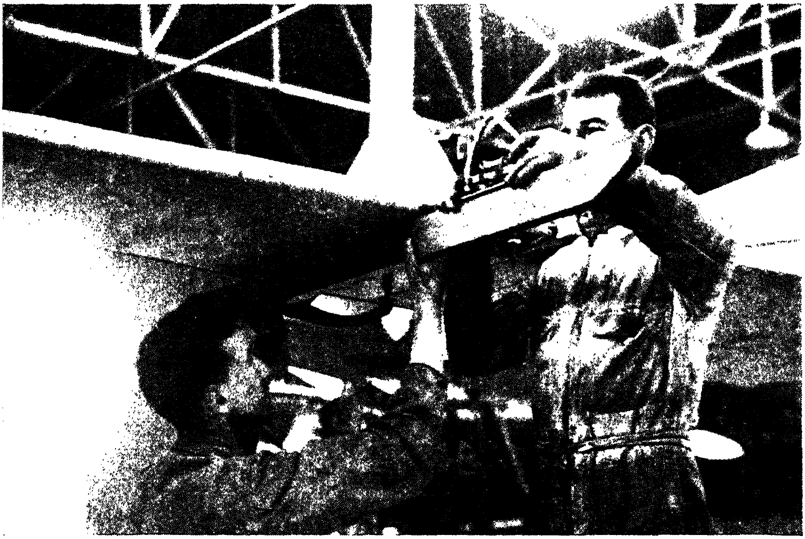


Fig. 36.—CHECKING INCIDENCE AT OUTER STRUT.

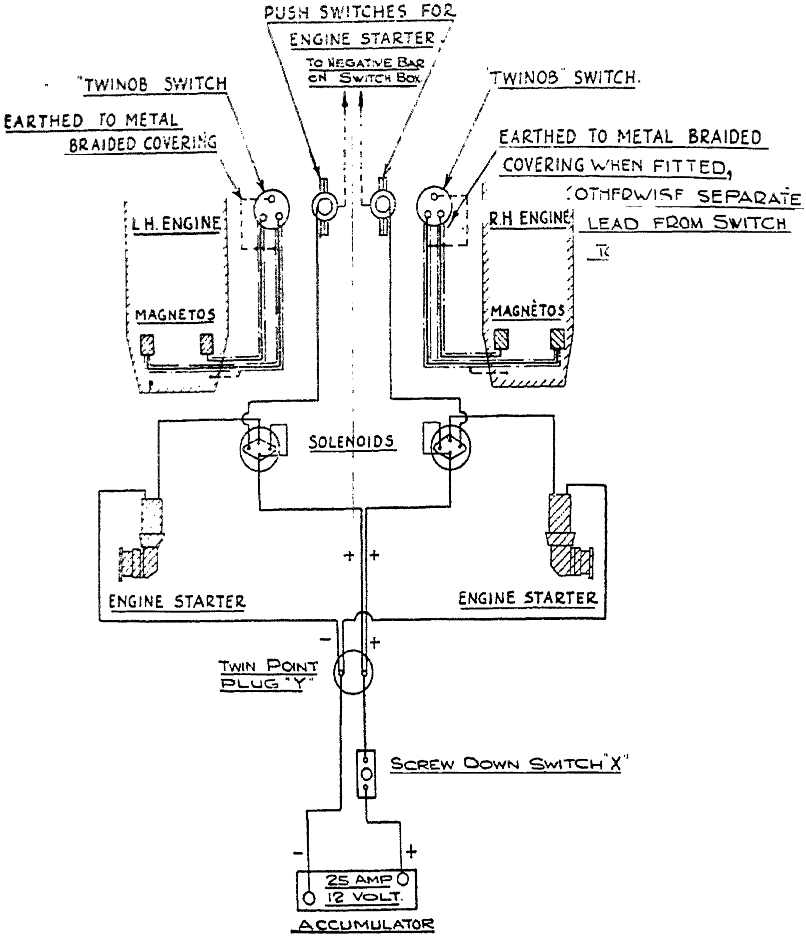


Fig. 37.—IGNITION AND STARTER WIRING DIAGRAM.

Note.—The aircraft accumulator is primarily intended to supply the lighting and wireless current and is only to be used for engine starting if ground accumulator equipment is not available, in which case switch " X " must be screwed down to join up aircraft accumulator with starter system and unscrewed when the engines are started. It is most important that the aircraft accumulator should be used as infrequently as possible for engine starting. A twin point plug is provided, as shown at " Y," for connecting to the ground equipment for normal starting.

6. Any stretch which may occur in the cable G can be taken up by turnbuckle Q. This adjustment should not be used to take up wear, for which see below. The pawl K on hand lever is self-engaging, and is thrown out of gear by pressing knob at top of the lever.

Fig. 38.—CHECKING STAGGER AT OUTER STRUT.

Adjustment for Wear

This is carried out by rotating the star wheel by means of a screwdriver inserted in the slot provided, and the hand should move inwards towards the axle to expand the brake by using the slot in the casting as a fulcrum.

CAUTION. The adjusting turnbuckles must not be used to take up linings, but only for initial setting or to compensate for any stretch in cables. Stretch should be negligible, as the cables are proof-loaded to half their breaking strength before fitting.

It is most important that these principles of adjustment for wear should be thoroughly understood. Instances have occurred where incorrect adjustment has caused snatching, resulting in bursting of the axle retaining caps with grave consequences.

The Air Ministry have called attention to this in their "Notice to Aircraft Owners and Ground Engineers" No. 38 of the year 1936.

MAINTENANCE ROUTINE

Inspection of the Dragon Rapide

The Dragon Rapide is essentially a commercial aeroplane and therefore will be normally inspected and maintained by a staff of Licensed Ground Engineers. Their training will indicate the nature of the necessary

Fig. 39.—ADJUSTMENT AT OUTER STRUT.

Showing bottom of outer strut with cuff slid up and spanner on strut adjustment nut.

routine and work to enable them to sign out the aeroplane for daily flight, as required by the "Air Navigation Regulations," but the following covers broadly the points to be observed :—

(*a*) **Before Each Day's Flying**

1. Attention to pilot's previous reports, if any.
2. Inspect airscrews.
3. Inspect all covered surfaces for indications of

4. Check all controls for free movement and normal operation.
5. Inspect undercarriage, tail wheel and fuselage attachments for any signs of abnormal landing stresses.
6. Inspect wires, struts and structure generally for any signs of abnormal flying stress.
7. Inspect engines and installations to ensure no slacking, displacement, chafing or leaks, and rotate " Auto-Klean " filters.
8. Check fuel pumps independently by operating priming levers.
9. Test engines.
10. Verify that engine cowling is properly fastened.
11. Check accumulators for acid level and tightness of vents.

(*b*) **After a Bad Landing**

1. Examine shock absorber leg units, axles and radius rods. If any signs of bowing are apparent, components affected should be replaced, as strength is impaired.
2. Examine wheels.
3. Examine attachment joints to main structure, verifying that no

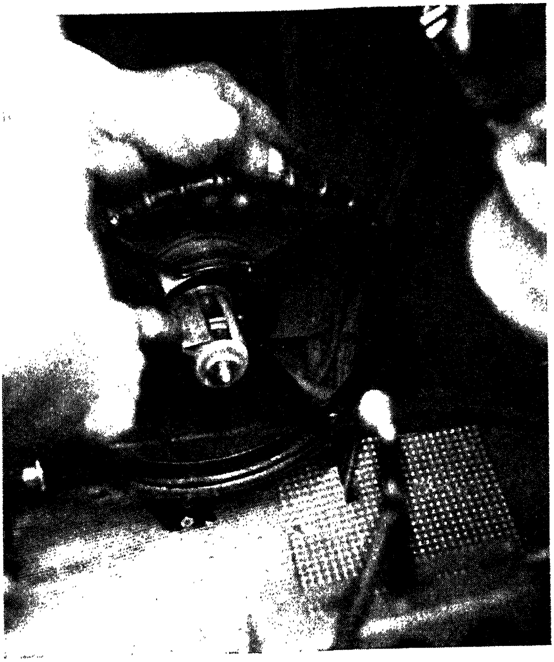


Fig. 40.—THE TAIL TRIM WHEEL IN PILOT'S COCKPIT.
Showing indicator at neutral.

displacement, partial shear of pins or elongation of holes has occurred.

4. Examine fuselage members forming the structure between attachment joints, tail wheel gear and adjacent fuselage structure. Rucking of fabric or plywood and cracking of paint are indications that opening up is advisable.

5. If the wing tip has come forcibly into contact with the ground or other object, the most likely place in which to look for damage is at or around the point of attachment of the main interplane struts and the root end attachment joint to the centre plane structure. In the case of the rear spar, look also at end around the inner aileron hinge fitting, and at the ends of the packings on spar at interplane struts. These points can be examined by making small incisions in the fabric coverings, which must, of course, afterwards be sewn up and covered with doped-on frayed-edge patches, at least 1 in. larger all round than the size of the cut.

(*c*) Special Points to be Observed

In the case of an engineer examining a particular Dragon Rapide for the first time, the following special points should be observed :—

1. In accordance with the requirements of the Ground Engineer's Notice No. 26 of 1935 the induction pipe drains must be $\frac{5}{16}$ in. outside diameter (the early ones were $\frac{3}{16}$ in.). This is to minimise the fire risk on starting up, as should the long small diameter pipe become stopped by congealed oil a quantity of fuel may collect in the induction manifold, and be blown in liquid form through the exhaust, when the engine starts. If the drains do not run freely when carburetter is flooded this should always be investigated and remedied.

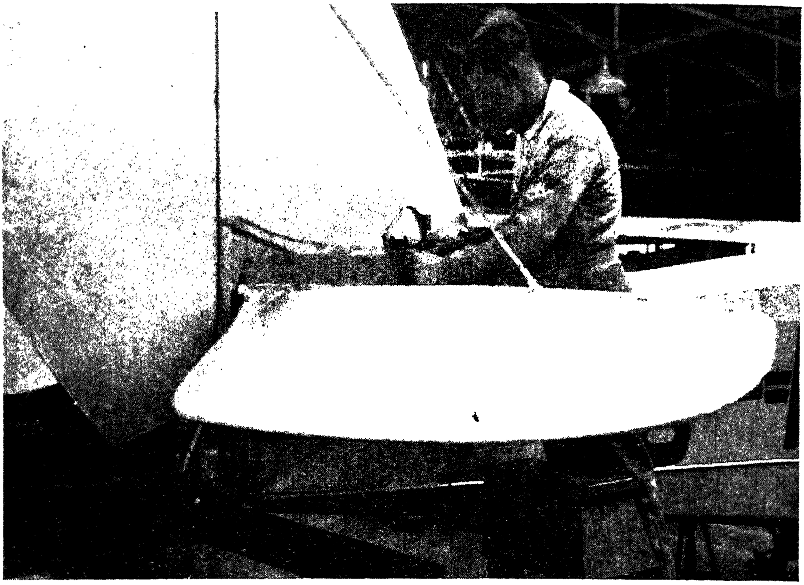


Fig. 41.—CHECKING INCIDENCE OF TAIL PLANE.

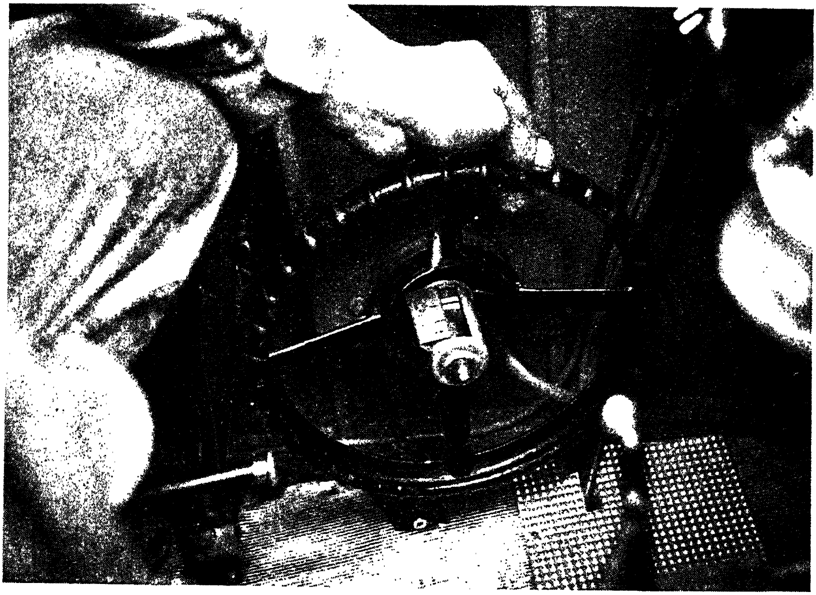


Fig. 42.—CHECKING FULL TRAVEL UP AND DOWN.

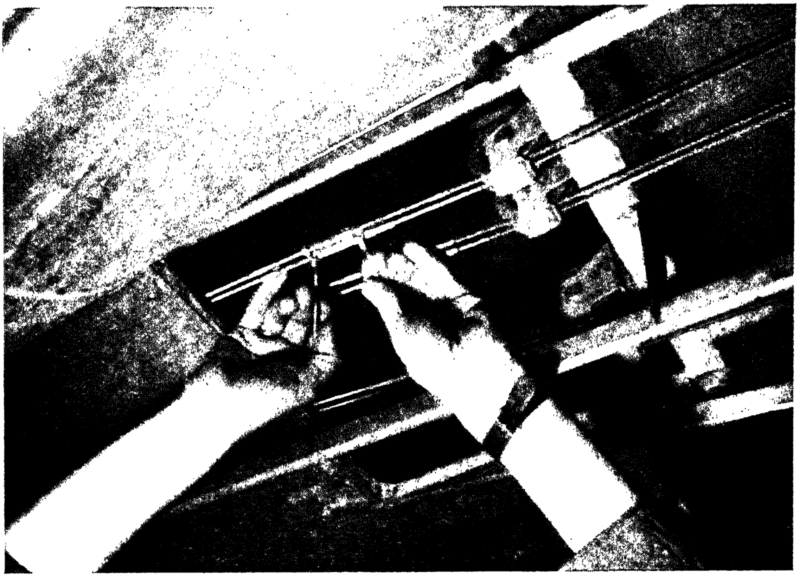


Fig. 43.—ADJUSTING RUDDER CABLES.

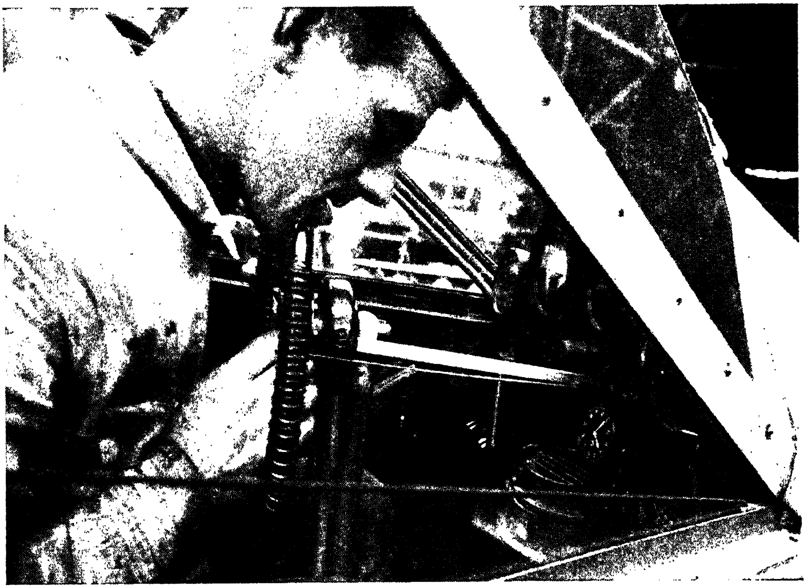


Fig. 44.—SETTING CONTROL COLUMN.

Measuring distance from control column to instrument board. This should be 7·75 in.

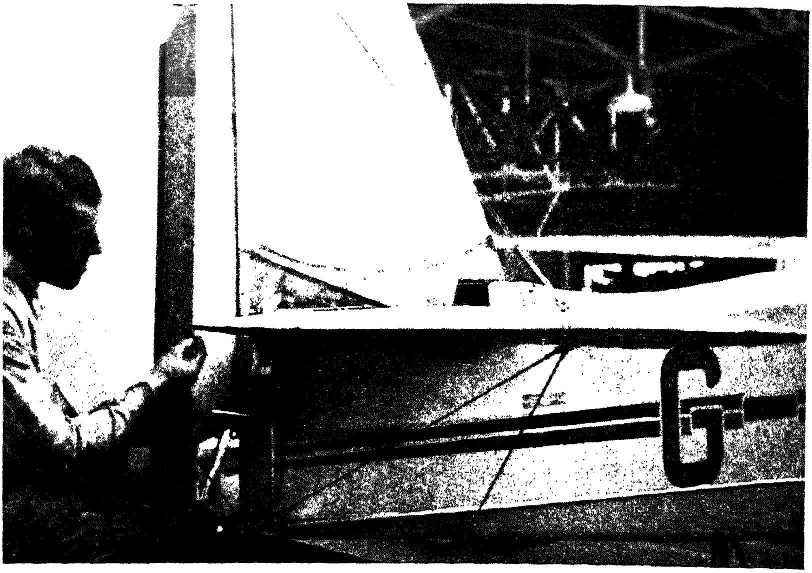


Fig. 45.—SETTING THE ELEVATOR.
Using vertical straight edge with elevator neutral (in line with tail plane).

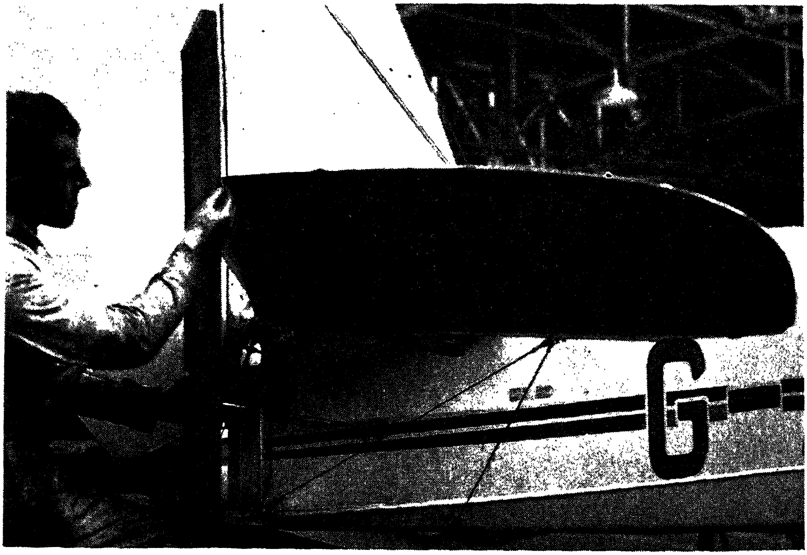


Fig. 46.—CHECKING TRAVEL OF ELEVATOR.

Fig. 47.—SETTING AILERON DIFFERENTIAL.
This is measured with a rule and should be 1·85 in.

WARNING. The hole through the attachment nipple at the induction end remains the same and must not be enlarged, as this is a leak hole in the induction system and an alteration to this would be detrimental to the mixture distribution. As this is continually washed by the fuel there is little tendency for this to become stopped, but should it be noticed that the drains are not flowing freely when flooding the carburetter on starting up, this should be examined and cleared. Excessive flooding of the carburetter should be avoided, which will also minimise this fire risk.

2. Ground Engineer Notice No. 38 of 1936 refers to a strengthened axle cap. Any aeroplane delivered prior to February 7th, 1937, should be checked to ensure that the axle cap has been replaced by the new strengthened cap or later production issue. The new cap can be identified as the thickness of the lug through which the bolt passes which is ·6 in. minus half the gap between the cap and top half of the axle housing.

After Every 25 Hours' Flying

1. Inspection by Licensed Ground Engineer, including the removal of all engine cowling and inspection covers and fabric lacings to facilitate an efficient examination of airframe, controls, airscrews, instruments, electrical equipment, engines and installation.

2. Cleaning and protective measures against deterioration and corrosion.

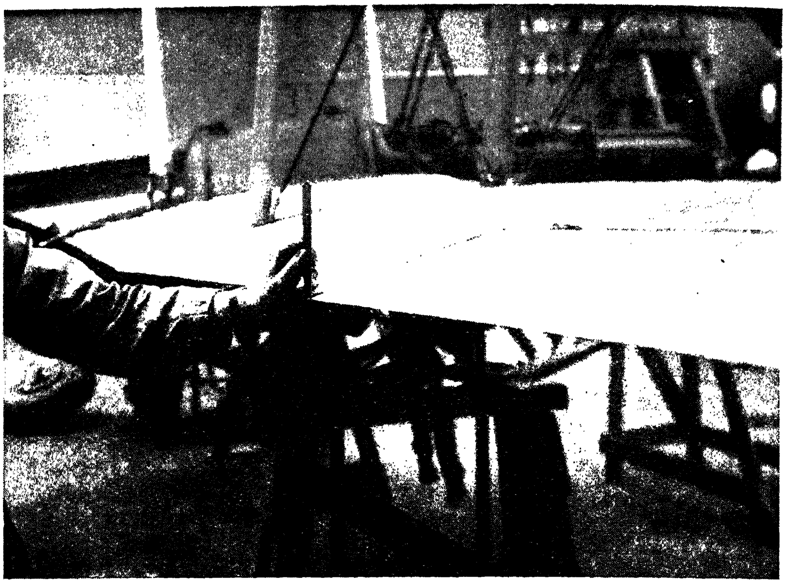


Fig. 48.—SETTING AILERON DROOP.

Fig. 49.—CLEARING DRAIN HOLES AT EDGES.

3. Lubrication of working parts.

4. Check and adjust tyre pressures.

5. Check valve clearances and re-set if necessary.

6. Dismantle, clean, re-set points and pressure test sparking plugs.

7. Clean suction and turn pressure oil filters.

8. Clean fuel filters and drain sumps of fuel tanks.

9. Remove and check carburetter jets and flush through float chamber.

10. Check contact breaker gaps and clean distributors.

11. Drain oil system and fill with new oil.

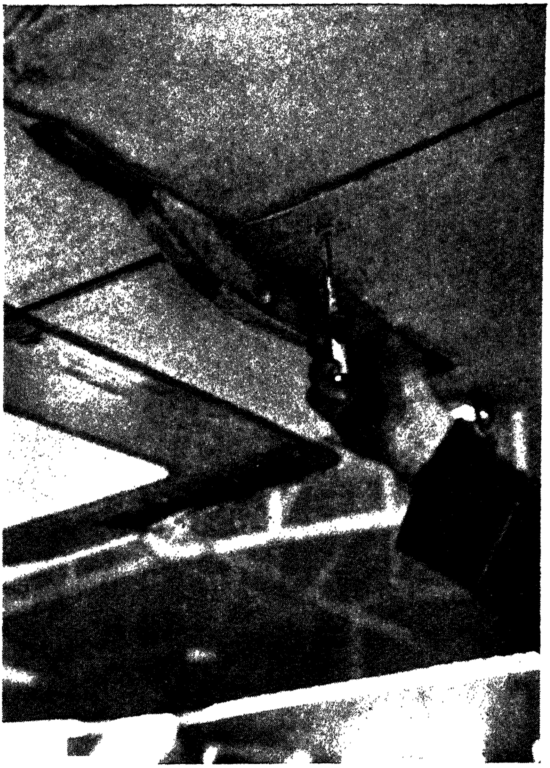


Fig. 50.—CLEARING DRAIN HOLES NEAR AILERON CONTROL SPROCKET.

12. Before replacing valve gear covers, add engine oil to bring up to the level of ring on vent pipe.

13. Check tightness of airscrew bolts. This should be done more frequently if the airscrew is new or if the aeroplane is operating in a hot climate.

14. Attention to electrical equipment, such as generators, cleaning of commutators, brushes and accumulators, checking of acid, and level and tightness of vents.

15. Run engines.

NOTE. Where " Zip " fasteners are provided to facilitate inspection it is advisable not to leave these in a released position for long periods, such as overnight, as the doped fabric has a tendency to contract, and a big strain would be imposed on the fastener when attempting to close.

The above schedule is intended to apply when 25 hours' flying is completed in a normal period of time. If the period is unduly long, additional Ground Engineer's inspections are advised. The same advice

Fig. 51.—CLEARING DRAIN HOLES IN FUSELAGE.

applies should the aeroplane experience rough usage or abnormal conditions or show symptoms of irregular running.

After 250 Hours' Flying

The " Auto-Klean " Filter should be dismantled and cleaned.

After 600 Hours' Flying

The engines should be taken from the airframe and given complete overhauls.

Annual Overhaul

In accordance with the Air Navigation Regulations the airframe must be inspected and overhauled to the requirements of the official inspection authority for recommendation for the renewal of the Certificate of Airworthiness.

Repair of the Dragon Rapide

Engineers who propose to undertake repairs to the structure should acquaint themselves thoroughly with the Notice to Ground Engineers No. 16 of the year 1937, headed : " Manufacture and Inspection of Aircraft Parts and Approval of Materials for the Repair or Overhaul of Licenced Aircraft."

Typical repair schemes have been prepared by the manufacturers and approved by the Air Ministry, and a ground engineer licenced in the appropriate category can, on satisfying himself that a typical method as shown is applicable to the repairs needed, carry out the work, quoting the drawing number in the log books, without reference to higher authority. The following schemes are available :—

Fuselage repairs	Fig. 26
Rib repairs	Fig. 27
Repairs to aileron spar tip	Fig. 28
Repairs to leading and trailing edges	Fig. 29
Repairs to spar ends	Fig. 30

Tail Wheel

With reference to Fig. 22 the following additional information is given with regard to the fitment of new shock absorber rubbers and for adjustments during service.

To Fit New Rubbers

1. Remove fork complete with wheel from the main shock absorber unit.
2. Remove top centre nut of shock absorber unit and withdraw the inner sub-assembly.
3. Remove top fitting of inner sub-assembly which is attached by a row of setscrews.
4. Unscrew centre tension rod when old rubbers with spacers can be removed.
5. Reassemble with new rubbers (9 in number) with spacers in position as indicated on Fig. 22.
6. The centre tension rod should then be screwed up until the dimension from the centre of the hole in the tension rod to the top side of the top rubber is 7¼ in. The whole unit is then reassembled in the reverse order as given for dismantling and attached to the airframe.

With the aeroplane empty and standing on the tail wheel the rubbers will compress and when newly assembled show a gap of approximately ⅝ in. between the bottom edge of the lower end fitting and the rubber stop block on the fork. During service this gap will naturally increase to approximately 1½ in. due to the settling down of the rubbers. A proportion of this settling down can be taken up by a later screwing up of the centre tension rod. This adjustment, however, must not be continually made if the resiliency of the rubbers has been lost due to continual service or age; in this instance the rubbers should be renewed.

Steel Sprung Undercarriage Leg (See Fig. 21a)

To enable internal mechanism to be examined for overhaul, or possibly to replace a broken spring, the procedure for dismantling is as follows :—

1. Remove leg from aeroplane.
2. Remove two top bolts. Owing to slight initial compression of

springs, it is suggested that end force be applied to strut. This will enable bolts to be easily tapped out. The top socket can now be removed.

3. Remove two bolts holding lower fitting, also rivet (on later types this rivet is not fitted). This will allow the bottom telescopic tube to slide upwards and off the lower fitting, when the rivet can be removed.

4. Bottom spring and lower fitting can now be withdrawn from below. The remaining internal fittings can be withdrawn through the top of the outer tube, and completely dismantled. Attention should be given to the following :—

(*a*) Wear on bronze liners.
(*b*) Wear on main sliding tubes and small centre tube.
(*c*) Wear on friction cones.

Assembly is carried out in the reverse order. Should the parts have been cleaned of grease to facilitate inspection, they must be re-smeared, but no attempt should be made to fill up the interior with grease, as this would seriously affect the working of the unit by becoming compressed in the restricted space occupied by the springs under compression.

NOTE. A charge of oil through the nipples located immediately above the lug should be given during the 25-hour maintenance inspection.

TESTING AND INSPECTION OF REID TURN INDICATORS

By Wing-Commander G. W. Williamson, O.B.E., M.C., M.Inst.C.E., M.I.Mech.E., M.I.E.E.

DURING the process of assembly of the Reid Turn Indicator, whether the instrument is new or has just completed an overhaul, a prolonged routine of tests and inspections is carried out. This falls into two parts :—

1. Examination and testing of the separate components prior to assembly.
2. The inspection and test of the complete instrument, frequently carried out in the presence of an inspector of the Aeronautical Inspection Department.

Examination of the components is the responsibility of the assembly shop, although there are members of the Inspection Department working in the shop, and these may carry out checks at suitable intervals. Examination and testing of the complete instrument is the responsibility of the Inspection Department, and a small percentage of those passed out are personally tested by the visiting or resident A.I.D. officer.

Tests on Inclinometer Box

In the usual order of assembly, the first component to be tested is the inclinometer box, illustrated on page 222 of Vol. I. It is necessary to check that the damping is efficient when the pendulum swings from one end to the other of its travel, also that there is no sticking. A single test can be applied to each inclinometer box which would reveal defects in either of these points : the box is tested when fitted to the back of the dial and coupled to a centre dial known to be free ; the whole dial is then tilted until the top needle reads 20°, the dial then being sharply restored to the vertical ; the needle should swing without interruption back to zero and may pass it by not more than 1°. If the damping were insufficient, the needle would swing beyond the zero ; and if there were sticking at either side of the centre point of the scale the needle would not come right back to the zero. The same test can be carried out holding the instrument truly vertical and gently pressing the needle first to the left and then to the right as far as the 20° mark.

It should here be explained that the centre dial is the flat circular piece of metal in the middle of the main dial and separate from it ; on this disc, which bears the serial number of the instrument and the maker's name, the inclinometer needle is pivoted and operated by a small projection emerging from the inclinometer box.

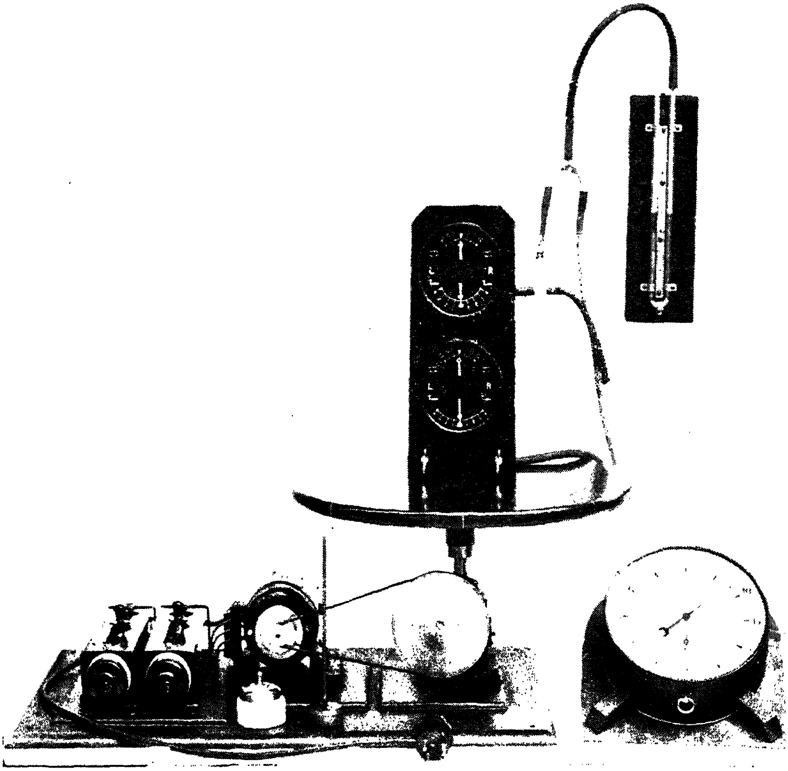


Fig. 1.—REID TESTING TABLE FOR TURN INDICATORS.

Tests on Rotor Unit

Apart from the detailed general inspection of the rotor unit, the most important test is that for vibration either on the pointer or in the bearings. By means of a compressed air jet the wheel is run up to 5,000 or 6,000 revolutions per minute; it is then possible for a skilled man to feel by gently touching the projecting pointer whether or not there will be vibration if the unit is assembled into an instrument in that condition. Similarly, skilled mechanics or inspectors, after suitable training, are able to identify and locate vibration due to the balance; if the rotor unit does not pass this test it is sent back to the assembly bay for further adjustment.

Testing of Dashpots

The same type of dashpots is employed in any type of Reid Turn Indicator; and although this article deals chiefly with the two-needle type of turn indicator, dashpot inspection would be exactly the same in all three types. The appearance of the dashpots may be seen from the line drawing on page 227 of Vol. I.; the illustration in question showing the rotor unit dashpots and liquid horizon belonging to a Gyorizon. Tests which are suitable for the testing of damping or sticking in the Inclinometer box, are also suitable for the testing of the dashpot unit, to make sure that the damping is sufficient and that the pistons are not sticking at any part of their travel. The needle is pressed to the limit of its travel at either end of the scale and allowed to swing back freely. In this case, it should not pass the zero by any appreciable amount—that is, the gyro pointer (the bottom needle) must be dead beat.

Dial and Centre Dial

With the instrument now almost completely assembled, the final assembly tests can be applied to the dial, centre dial and pointers. First of all, a general inspection of the dial is made to ensure that the pointers are working perfectly freely, that they are not too close to the centre dial on the one hand or at the pointed end not too far away from the main dial, in which case there might be a possible parallax error.

Static balance of the rotor unit is tested by turning the whole instrument sideways until the turn needle is approximately horizontal, when it should still stand exactly at zero both when it is pointing to the left, horizontally or to the right. The assembly is tested for starting; the rotor must commence to run on a suction pressure of not more than $\frac{1}{4}$ in. of mercury and must continue running. An approximate calibration is rapidly carried out to make sure that an adjustment of the sensitivity spring will bring the complete unit within the required limits of accuracy when the instrument goes forward to its final calibration. Tests for damping and sticking are repeated, together with a test applied in such a way that with the gyro running both needles are at the extreme limits of the scale first to the left and then to the right; this is to ensure that there is no interference by one needle with the other.

If the instrument passes all these tests, it is then completely assembled and passes through a second series as the complete instrument.

Assembly Tests of Completed Instruments

Most of the tests on the completed instrument are a repetition of those applied to the components in their dismantled condition. Once again a test is made as regards starting on $\frac{1}{4}$ in. of mercury; both needles are pressed lightly to the end of the scale at either side in order to make quite sure that they will give the full reading without coming up against the limit stops. Then, with the gyro running, the instrument is examined for accuracy of zero, the distance of the pointer from the dial, and once again checked in regard to the possibility of vibration. Damping is again checked, the instrument when running examined for any oscillation or dither of the needle and a preliminary inspection made of the luminising in order to confirm that it will be up to standard.

Zero position is checked, both at rest and when the wheel is running; and if all the previous points are quite correct, the instrument goes forward for calibration.

Description of Reid Turning Table

As the purpose of the turn indicator is to show various rates of turn of an aeroplane in the air, the instrument is calibrated by being subjected to turns of known speed on the ground; the dial readings being adjusted to correspond with the figures given on page 222 of Vol. I., for the two-needle Turn Indicator, and page 227 of Vol. I., for the Gyorizon or commercial Turn Indicator.

These turning tests are carried out on a turn table illustrated in Fig. 1, which shows the complete outfit.

The turn table consists of a circular wooden table spigotted into a gear box which is concealed behind the pulley. The pulley is connected by a rubber belt to a small motor, the reduction of the gear box alone being about 1000 : 1. Both gear box and motor have 3-speed pulleys; and in addition the speed of the motor can be varied over a very wide range by means of two variable resistances connected in series. In front of the motor can be seen a reversing switch, enabling the instrument to be tested for turns either to the right or to the left; while next to that switch stands a pointer which, used in conjunction with marks on the edge of the turn table, permits readings to be taken of the time in seconds over a known fraction of a complete circle; thus the time may be taken for turns through 180°, 90° or 45°; in actual practice not less than 90° is advisable.

The time is taken by means of a large stop-clock shown in the illustration. Two instruments at a time can be tested, the suction pressure being adjusted to 3 in. of mercury as measured between the two legs of the manometer shown, which is supplied with this outfit. When a source of suction pressure is not available in the workshop or repair shop, a small compressor is separately supplied, the suction side of which is used for driving the two instruments.

Calibration Adjustment of Turn Indicators

In carrying out a calibration test, the compressor is started so that the air supply is available and the two instruments in the frame are connected through a manometer by means of a T-piece. The pressure is adjusted to 3 in. of mercury and the instruments allowed to run for ten minutes before beginning to test for timing.

As the resistances are in series, both switches must be down before the circuit is complete; resistance is adjusted so that when the table is in motion the bottom needle on the instrument being tested stands exactly at Rate 1, either to the left or to the right of the centre point. Keeping

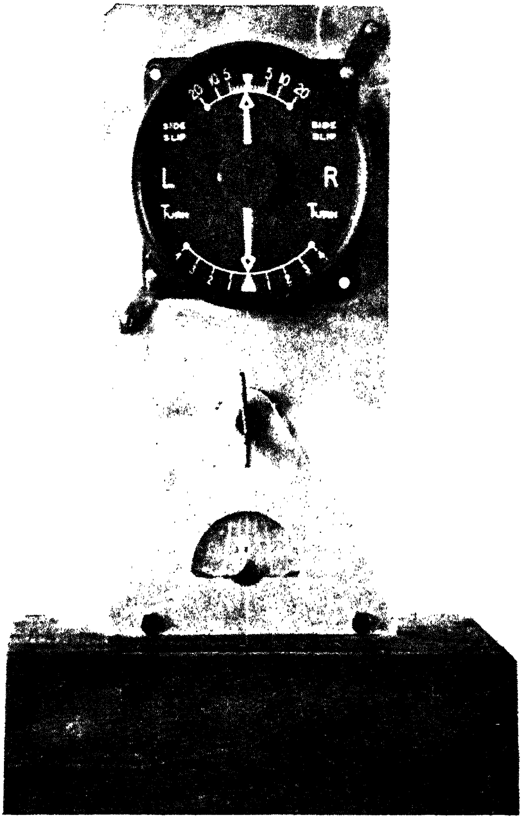


Fig. 2.—JIG FOR TESTING INCLINOMETER.

the needle perfectly steady at that division, the movement of the table is timed through a 90° turn: the result, multiplied by four, should give the time for a complete turn as shown in the table on page 222 of Vol. I., if the instrument being tested is a two-needle Turn Indicator; or on page 227 of Vol. I., if it is a Gyorizon or a commercial model instrument.

When the instrument has been tested on rate 1 in one direction, the table can be reversed and a similar test carried out on the other side of the zero. It is usual to switch off one or both of the resistance switches, throw over the reversing switch and start up again. The variation between the right side and the left side must not be more than five seconds on a 90° turn at Rate 1 for a Mark 1 two-needle instrument; or three seconds for a Mark 1A.

The operation is repeated first for one side and then for the other on a Rate 2 turn. It is advisable to check between tests that the air pressure is still standing at 3 in. of mercury.

The turn table is provided with rubber driving-belts so that after it has rotated through a 90° turn in either direction, it can be pulled back by hand against the friction of the belt to the position at which it first started.

Testing for Overswing

While on the table, the instrument is tested for overswing. The table

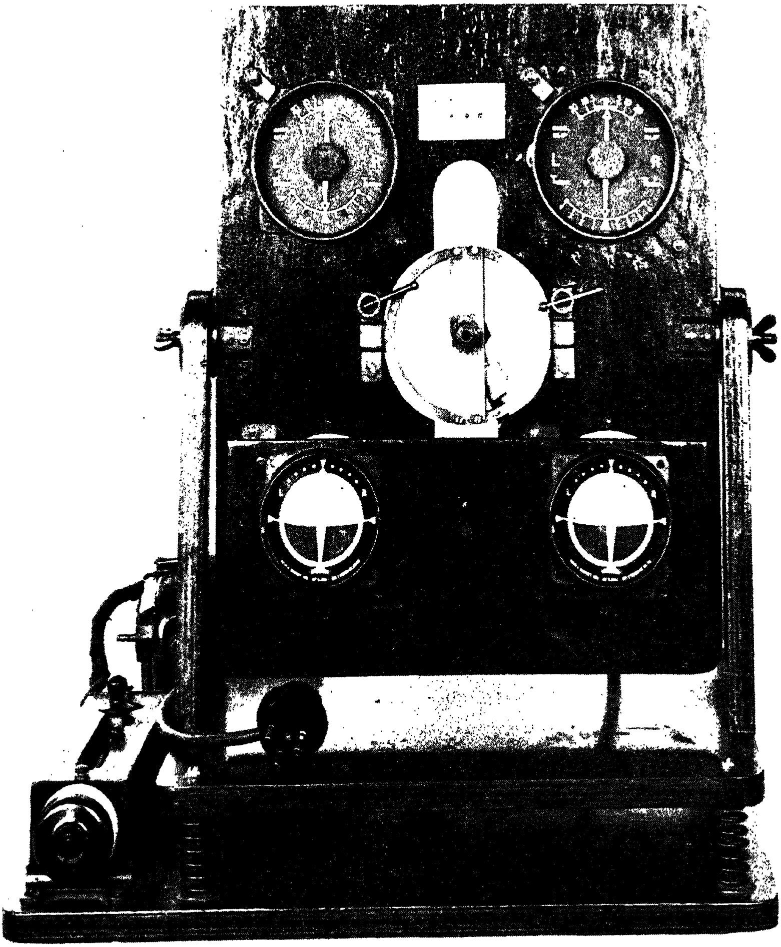


Fig. 3.—REID VIBRATING TABLE.

is pulled sharply by hand first to the right and then to the left sufficiently rapidly to make the pointer pass Rate 4 in either direction; when the pointer swings back to the zero, it must not pass it by more than ½° before returning to the centre point of the scale. This test is to be applied in both directions.

A further test is made by rotating the table with resistances full out, at the highest possible speed. On switching off, the bottom pointer of the instrument will fall from Rate 4 to zero; during the fall, the pointer must be carefully watched to see that it drops smoothly with no uneven movement; this test also is to be carried out in each direction.

Testing for Bank Indication

The instrument is then mounted on a jig, as shown in Fig. 2, calibrated with a scale of degrees. By this means the scale of the inclinometer is tested.

Calibration completes the work carried out by the assembly shop and the instrument is then passed to inspection.

Routine Inspection of Turn Indicators

The examination by the inspection department repeats in a large measure the tests already applied by assembly. The instrument is first of all tested for starting and running on $\frac{1}{4}$ in. of mercury; calibration of the Turn Indicator readings is checked on every instrument; the calibration of the inclinometer scale is checked once again by the use of a similar jig to that shown in Fig. 2. An examination of the zeros on each scale is carried out and the instrument carefully inspected to make sure that the needles will continue to read up to and beyond the last marking on the scale—that is, that the limit stops are correctly positioned.

These are the most important of the tests carried out on each instrument, and as stated previously, the inspection department's examination follows the same lines as that previously carried out by assembly.

A brief series of tests, entirely different, is, however, carried out specially on behalf of the Aeronautical Inspection Department. These include the testing of a proportion of the instruments while subjected to a vibration of 2,000 periods a minute. This proportion of the instruments must remain for one hour upon a vibrating table such as that shown in Fig. 3; the vibration is provided by an out of balance weight, driven at speeds varied by means of a motor with a variable resistance in the shunt. This vibrating table can be placed on the turn table and the calibration checked at the various rates under vibration of the stated periodicity. There must be no appreciable difference between the readings so taken and those obtained when the calibration was checked.

A similar small proportion of the instruments is tested for behaviour at low and high temperatures, *minus* and *plus* 60° C. These readings are obtained by mounting a freezing box or a heated chamber on the turn table, the calibration of the instrument being carried out as previously.

The luminosity of the instrument is checked in a dark room against the standard supplied by the National Physical Laboratory and the instrument is then sealed and packed ready for despatch.

THE REPAIR OF METAL HULLS AND FLOATS

By R. H. Longe, *Inspector, Saunders Roe Ltd.*

WHEN dealing with the question of hull and float repairs, it can generally be assumed that the damage to be made good is due to one of two causes. The member may have corroded to such an extent as to reduce materially its strength or else it has been damaged locally in hitting an obstruction during landing, taking off, beaching or launching. The question of structural failure or partial collapse in the air is remote in the extreme, although this cannot be entirely ruled out on experimental hulls and floats.

If the repairs are being carried out at a repair station properly equipped to deal with flying boats and float seaplanes, the region of the damage will not cause much trouble, as the necessary beaching chassis and cradle will be available. It sometimes happens, however, that the repair has to be carried out at some spot away from the normal facilities and these remarks may assist in such cases.

Spare Sections, etc., Carried with the Aeroplane

Before dealing with the method of repairs, it is advisable to say a word about spare sections, plates, rivets, bolts, tools, etc., that should be carried with the aeroplane. If the hull is of light alloy, that is, duralumin, it is advisable to carry two or three good-sized plates of alclad or anodised duralumin sheeting of the same gauge as the hull or float plating. If the plating is of the corrugated type, the spare plates should be likewise. Usually the plating in the region of the main step is a couple of gauges heavier than the remainder and allowance is made for this fact when deciding the nature of the plates to be carried as spares.

A number of smaller duralumin plates should be included of the same gauge as the keelson web and angles and also the chine bars and gunwales. These should be previously anodically treated.

A length of 20 gauge angle section 1 in. by 1 in. is often very useful for the purpose of local internal stiffening and should be included, in addition to a length of "Zed" section. A number of light alloy rivets used on the hull or float in question is necessary, the sizes varying from $\frac{1}{8}$ in. to $\frac{1}{4}$ in., and should include snap, pan and countersunk head types. A number of watertight bolts of the type having a slightly tapered shank below the head and a number of plain washers are extremely useful. They should be of stainless steel.

A good supply of marine glue and caulking cotton and at least three

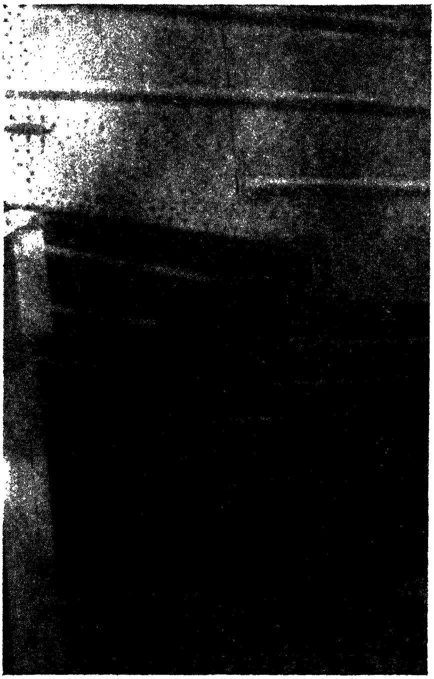
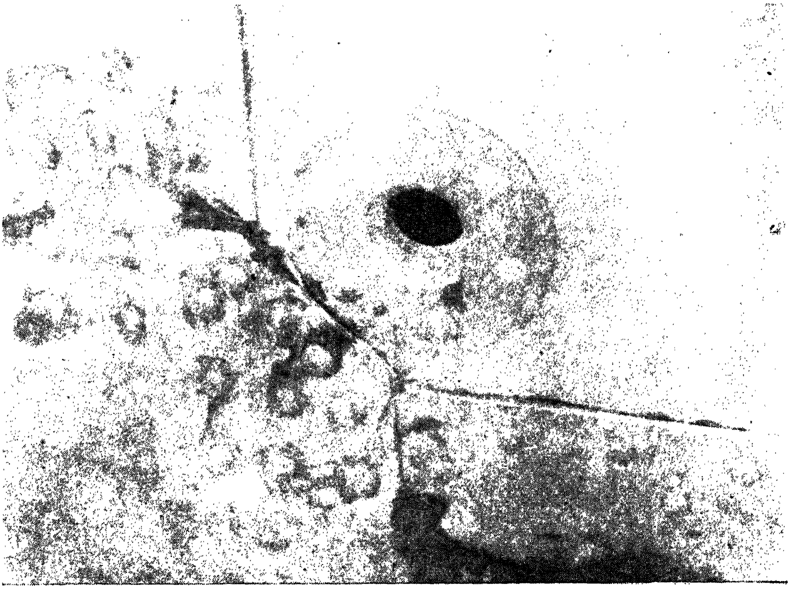


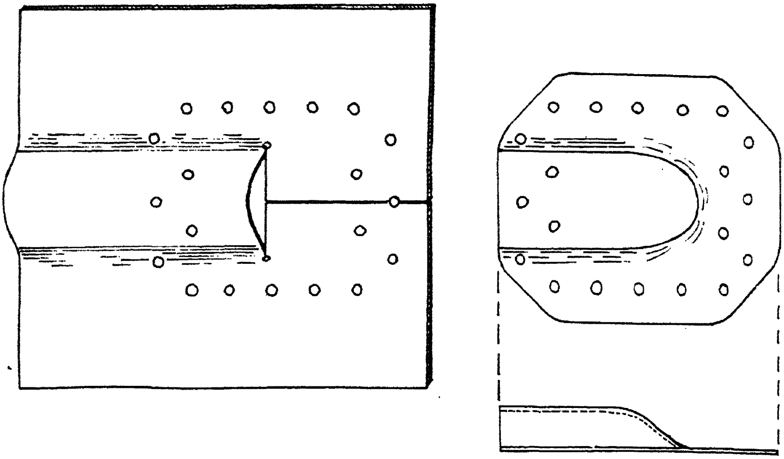
Fig. 1 (*left*).—THE HULL MAIN STEP.

Note the position of the cradle support directly under the main frame.

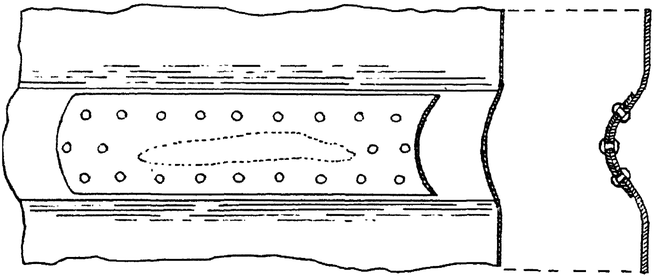
Fig. 2 (*below*).—THE MAIN DRAIN PLUG ADAPTER.

This is positioned close to the main step.





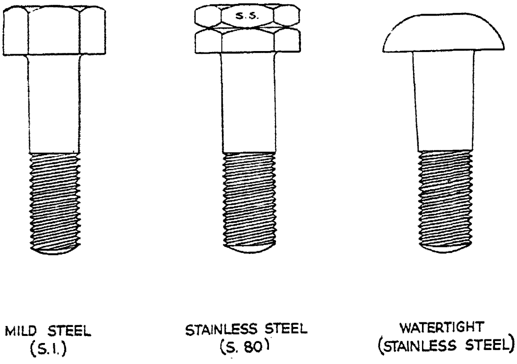
METHOD OF FITTING CORRUGATED "RUN OUT"



REPAIR TO CORRUGATION

Fig. 3 (*above*).—CORRUGATED PLATING FOR HULLS.

Fig. 4 (*right*).—METHOD OF IDENTIFICATION WITH MILD STEEL AND STAINLESS STEEL BOLTS.



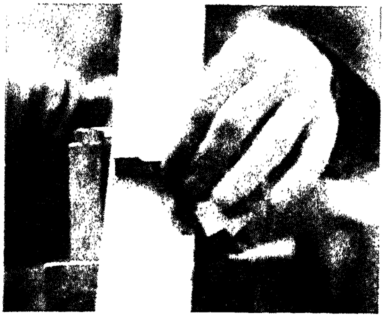


Fig. 5.—BEND RADIUS BEING CHECKED AFTER BENDING "ZED" SECTION FRAME MEMBER.

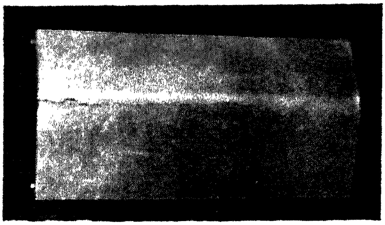


Fig. 6.—THE RESULT OF BENDING HEAVY GAUGE DURALUMIN SHEET WITHOUT SOFTENING AT 490° C.

holding-up tools or "dollies" will be necessary in addition to the normal kit of tools.

Riveting

Regarding the actual riveting, it is important that the holes in the plates or frames are not stretched or out of shape. Podgers or drifts should not be used to bring holes into line, as when the rivets are hardened up, the shanks will tilt and movement of adjacent plates will only be prevented by the clamping action of the rivet heads, which will not last for long. Care should also be taken to cut off any excess length before forming the rivet head, otherwise a "flash" will be formed around the latter, where corrosion will tend to set in.

The reverse of this, leaving too short a shank, will allow the snap to cut into the plate before a full head is formed and this destroys the protective coating on the plate with rapid corrosion as a result.

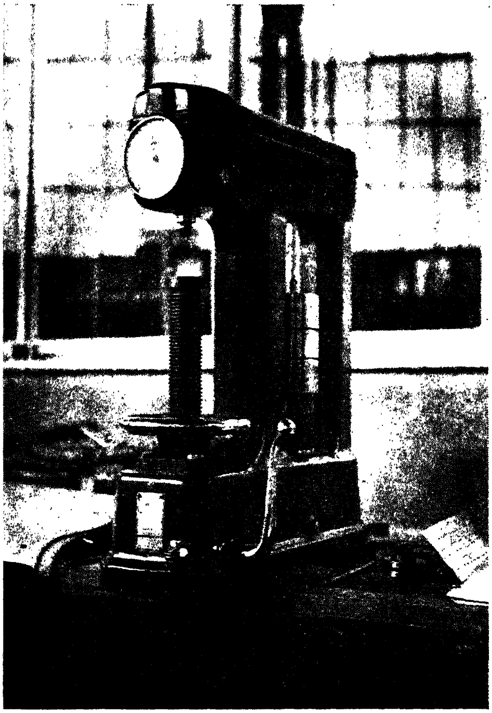


Fig. 7.—THE AVERY HARDNESS TESTING MACHINE.

Used for check purposes after heat treatment of duralumin sheet.

Fitting A Small Rectangular Patch Plate

Should a small indentation be found in the hull or float plating, due to striking a floating object, it should first be examined to determine whether the plate is cut or deeply scored. If this is so, the plate is dressed up and a small rectangular patch plate made, of the same material and gauge as the existing plating. A single line of rivet holes is then drilled around the edge of the patch plate at $\frac{7}{8}$ in. pitch to take $\frac{1}{8}$ in. rivets, either snap or countersunk headed, according to the general scheme on the hull or float. Corresponding holes are drilled in the plating.

The patch plate is given two coats of pigmented oil varnish after removing the burrs from the holes and finished with a coat of aluminium lacquer. Marine glue is smeared over both jointing faces and the riveting carried out, forming the heads on the inside in the case of snap or pan-headed rivets.

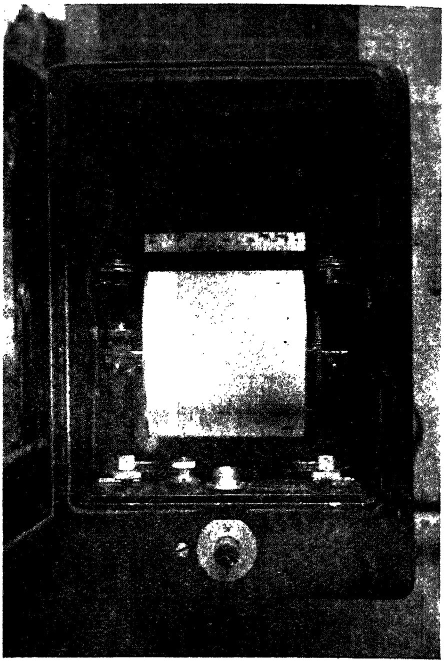


Fig. 8.—A MODERN TYPE OF PYROMETER IN USE—THE SELF-RECORDING TYPE.

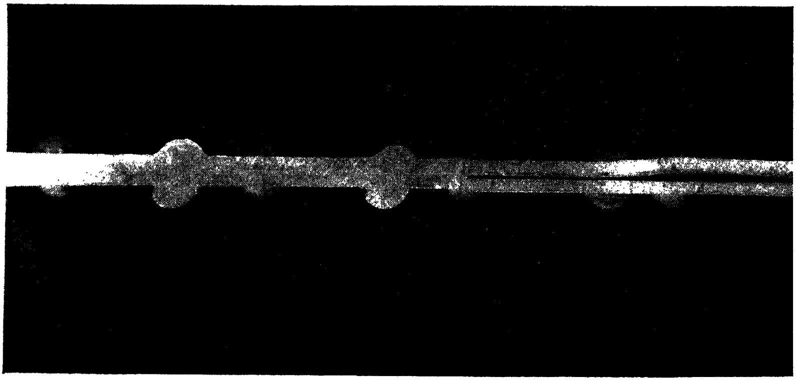


Fig. 9.—RIVETING FAULTS WHICH SHOULD BE AVOIDED. Showing plates not closed up and offset rivet heads.

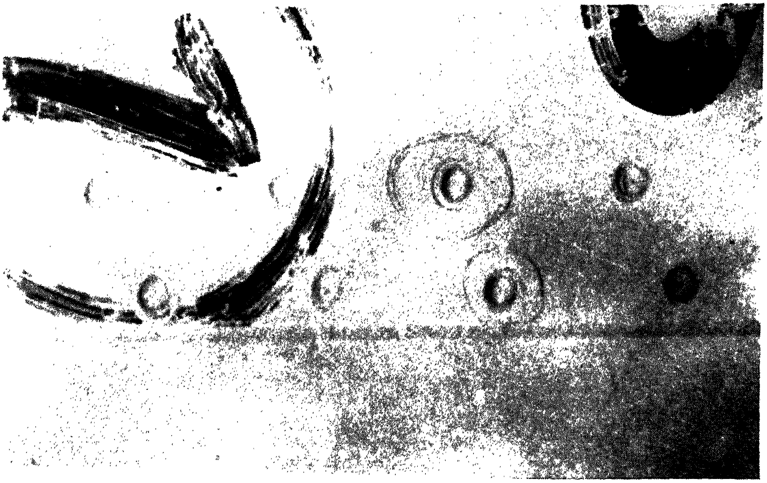


Fig. 10.—A POINT TO WATCH DURING REPAIRS.
Rivets that are too long have been used and have caused " flash " to be formed.

The light alloy rivets must be heat-treated before use at a temperature of 490° C. plus or minus 10° C. and used within two hours of this treatment. The rivets are quenched in water on removal from the oven or salt bath. If the latter is used, the rivets must be thoroughly washed in hot water to remove all traces of salt.

If the rivets are used without being heat-treated, they will be found too hard to work without cracking. The finished repair must be absolutely free from any signs of cracking around rivet heads. Where it is impossible to heat-treat the rivets, watertight bolts should be used below the water line and standard stainless steel bolts above.

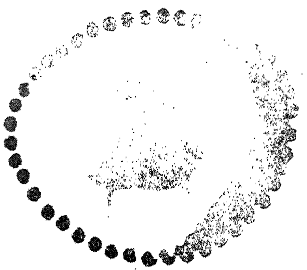


Fig. 11.—METHOD OF CUTTING OUT JAGGED SECTION OF PLATE BEFORE PATCHING.

Dealing with a Badly Holed Plate

In the case of a plate being badly holed, the jagged portion is first cut away. This is best done by drilling all round the area and breaking the piece out, afterwards cleaning up the edges. A patch plate is then made of the same material and gauge, large enough to give a 2 in. landing all round the cut-away portion.

Above the Water Line

If above the water line, single row riveting, with $\frac{1}{8}$ in. rivets at $\frac{7}{8}$ in. pitch, will be sufficient, allowing $\frac{1}{4}$ in. landing between the rivets and the edge of the patch plate.

Below the Water Line

If below water line, a double row of rivets should be inserted, the inner row being staggered in relation to the outer. The rows should be $\frac{1}{2}$ in. apart. Marine

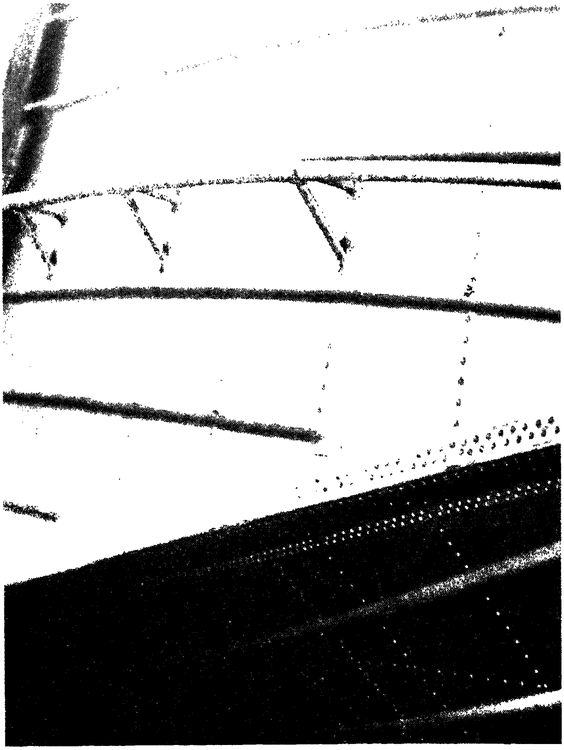


Fig. 12 (*above*).—THE HULL CHINE.

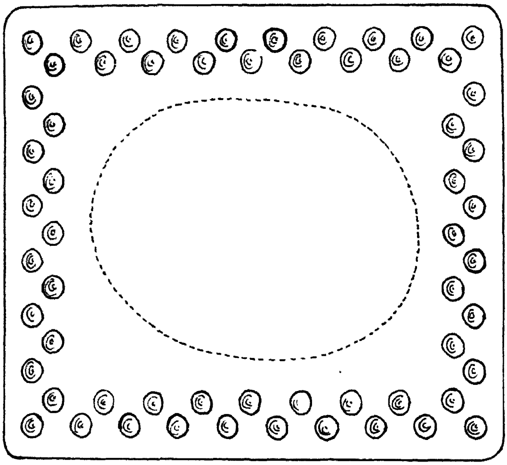


Fig. 13 (*left*).—A SIMPLE PATCH PLATE BELOW THE WATER LINE.

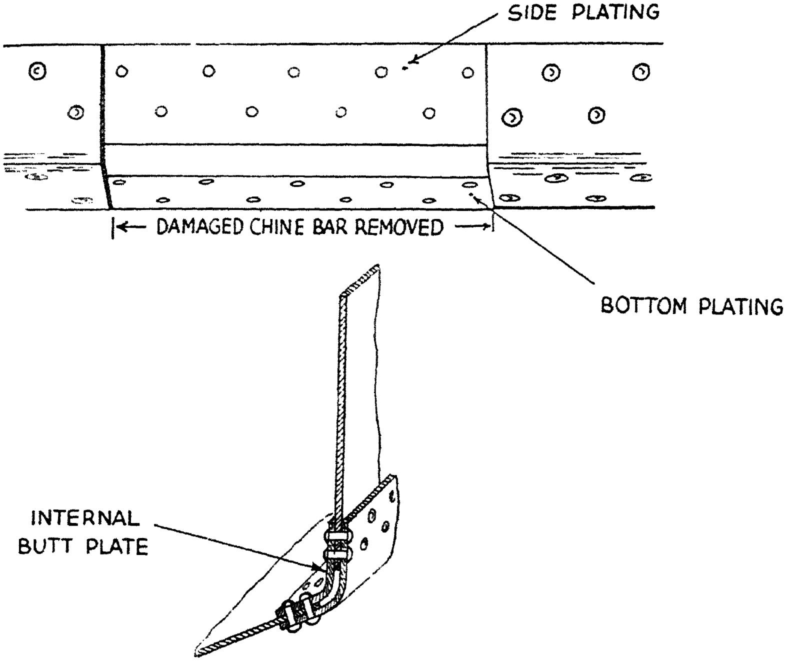


Fig. 14.—METHOD OF REPAIRING CHINE BAR ON HULLS.

glue and caulking cotton will be used on such a patch as this. After riveting, the edges of the patch plate are dressed down with a hardwood block to sit close to the plating. Any gaps left at the edges should be filled with marine glue.

Fitting a Half Plate

If the damage extends over a large area, it may be advisable to remove the entire plate and replace. Sometimes, however, a half plate can be fitted, the joint in the two halves being made by overlapping the joints, using a 1 in. lap and riveting the joint by means of $\frac{1}{8}$ in. or $\frac{3}{16}$ in. rivets in a double staggered row, using a 1 in. pitch.

Damage to Forward Chine Bars or Angles

It frequently happens that the forward chine bars or angles are damaged. When this occurs, the damaged section is removed by drilling and punching out the rivets and carefully cutting out the damaged portion. The plates are then dressed back to their original position and a new section of chine bar let in. The new portion is drilled from the existing holes in the plating. A short butt strap of the same section

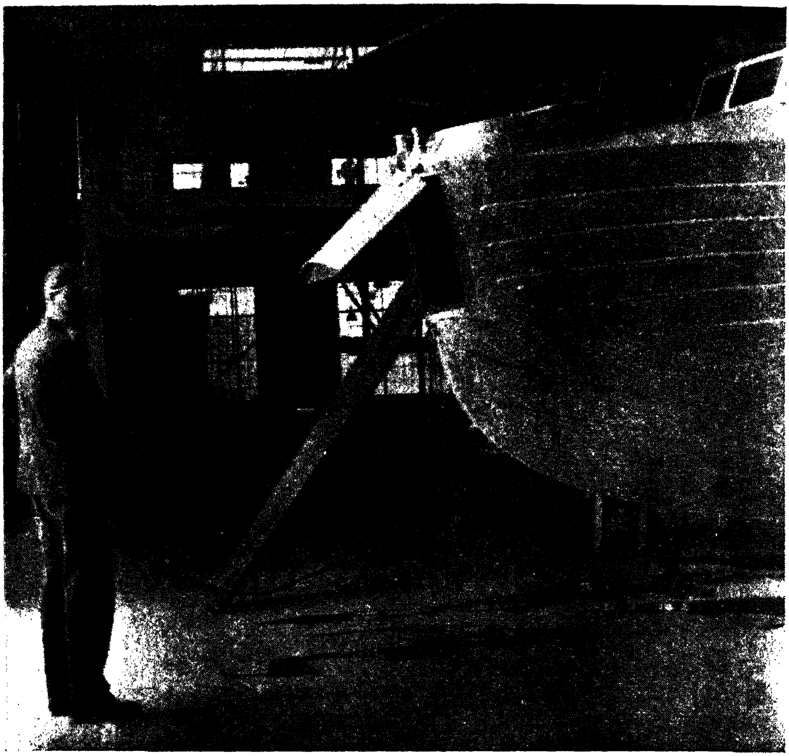


Fig. 15.—SHOWING ATTACHMENT POINTS OF TOWING PENNANT

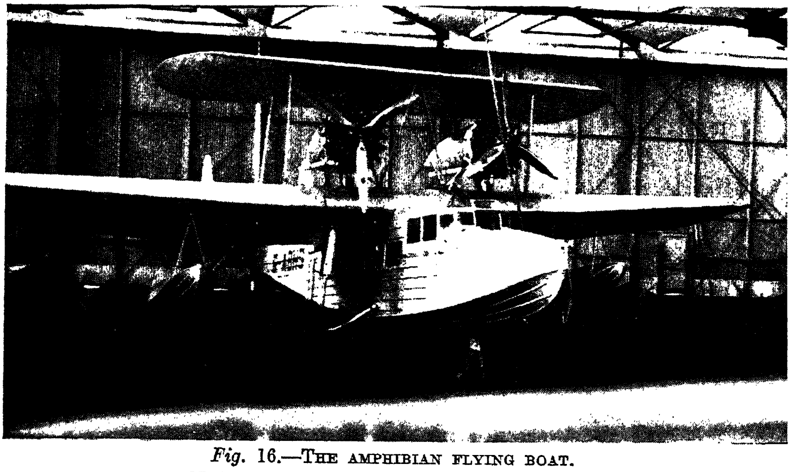
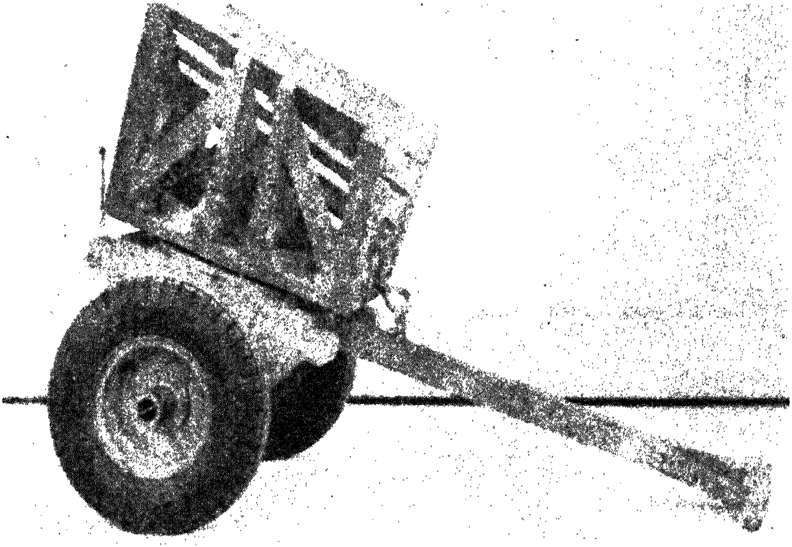


Fig. 16.—THE AMPHIBIAN FLYING BOAT.

No beaching chassis is required with this type.



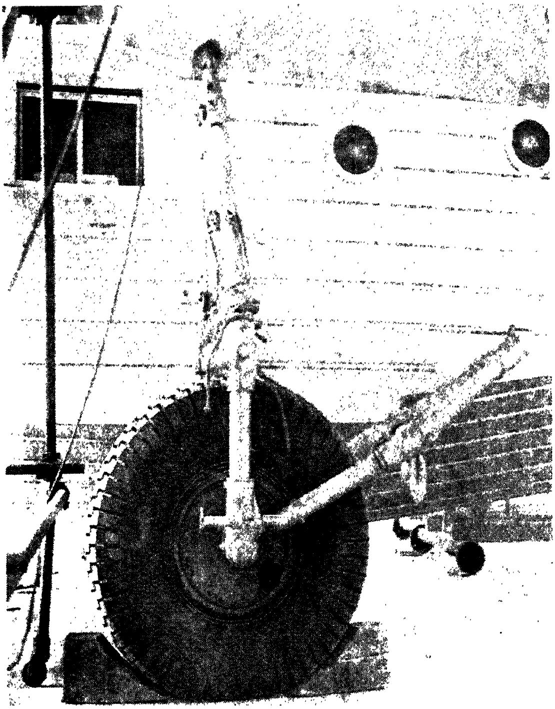


Fig. 17 (*above*).—THE HULL TAIL TROLLEY.

Fig. 18 (*left*).—THE BEACHING CHASSIS IN POSITION.

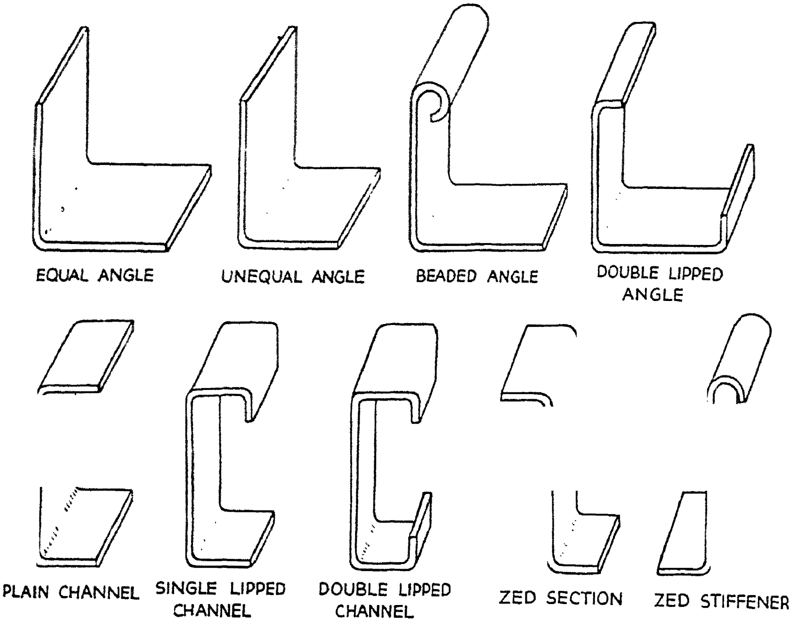


Fig. 19.—SECTIONS UTILISED IN REPAIR WORK.

and gauge as the chine bar is then fitted over the two butt joints, on the inside. Caulking cotton and marine glue should be laid between rivet holes before riveting up, if at, or below the water line.

Beaching a Flying Boat or Float Seaplane

Dealing with repairs below the water line will entail beaching the flying boat or float seaplane, either by means of a beaching chassis or cradle. When these are not available, the only alternative is to taxi the aircraft inshore and wait for the tide to ebb, leaving it grounded. Before it ceases to be water-borne, it should be amply supported, both below the main planes and also at the stem and stern and at various points along the chines. A large part of the weight will be taken at the keelson.

Time is usually limited by the tides in such a case as this and temporary repairs only should be made by fitting a liberal-sized patch plate, using nuts and bolts for attaching same. It is usual to fit a temporary patch on either side of the damaged region, this helping to press out any irregularities in the plating. A stout wooden beam placed between the two chines inside the hull or float will often enable the aeroplane to be flown back to its repair base if the main frames are damaged. Discretion will have to be used in such cases as this.

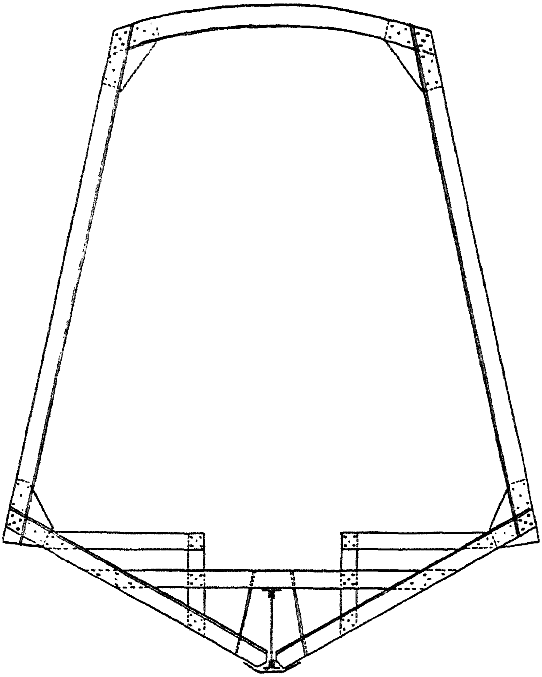
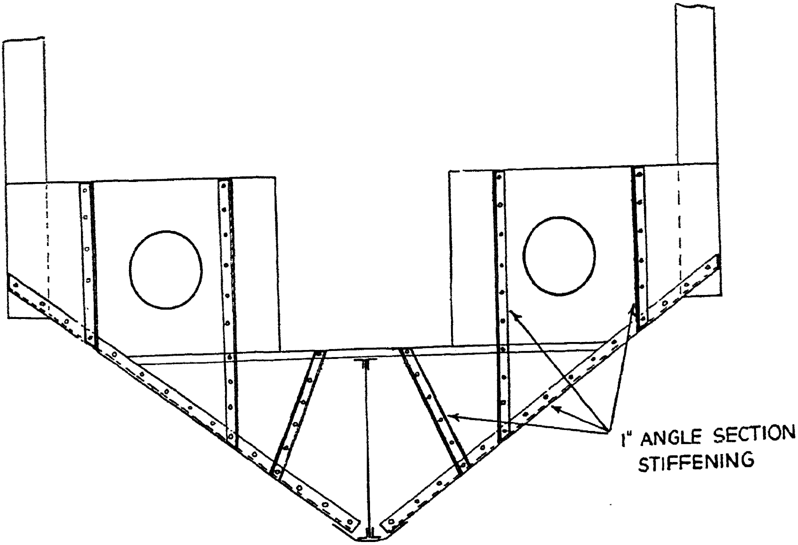


Fig. 20 (*left*). — How MAIN FRAMES ARE OFTEN MADE UP.

"Zed" section is generally employed.

Fig. 21 (*below*).—VERTICAL STIFFENING AT MAIN FRAMES.



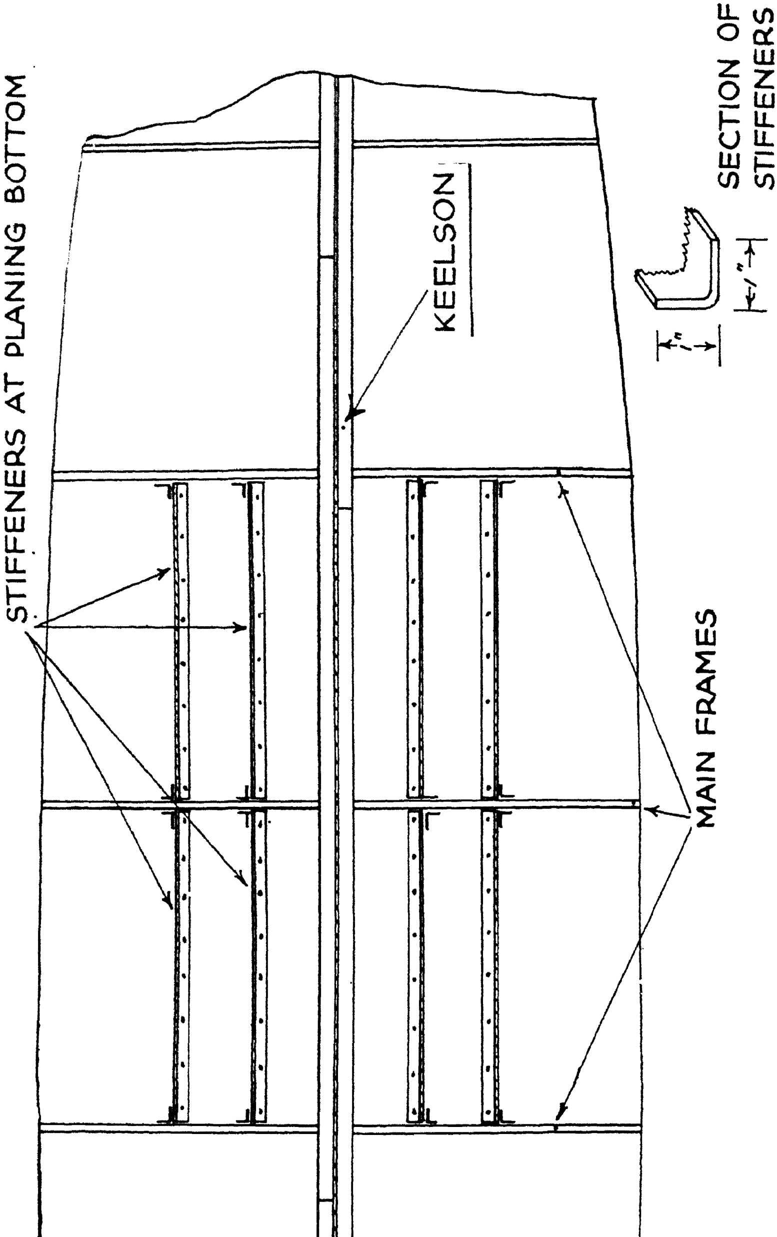


Fig. 22.—STIFFENING AT PLATING IN REGION OF MAIN STEP.

Replacing Corroded Plates

When plates are found corroded to such an extent that replacement is necessary, replacing the entire plate or half plate is preferable to local patching. It will sometimes be found necessary to joggle the plates where they overlap, but this is not necessary with plates of 20 gauge and under.

MAJOR REPAIRS INVOLVING ONE OR MORE FRAMES

Fig. 23.—HULL FRAMES AND KEELSON ON SADDLE BEFORE PLATING.

Dealing with major repairs involving one or more frames, the aeroplane will have to be cradled. Trestles or jacks are placed under front and rear main plane spars, taking care to keep a jack close in to the roots of the main planes on either side of the hull. This is to keep the bending loads on the spars down to a minimum. When amply supported, the cradle is lowered sufficiently to allow of removal. The keelson may then be supported at different points by means of a saddle or jacks.

The plating in the damaged region is removed, exposing the frames. Should a frame only be damaged locally, a new section is made up to replace that portion damaged, the angle of the butt joint being cut at 45 degrees. When making up the new section, the radii at the bends must be to the limits laid down for light alloy sheet. For fully heat-treated and aged material this radius must not be less than two and a half times the gauge of the material for 22 gauge or thinner and not less than three

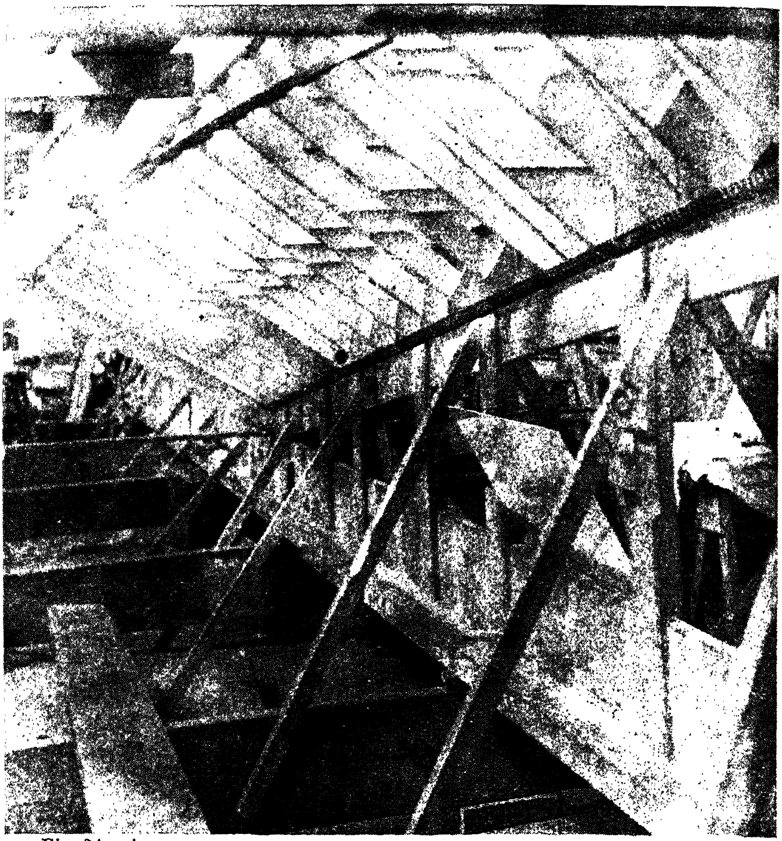


Fig. 24.—ANOTHER VIEW OF HULL FRAMES AND KEELSON ON SADDLE BEFORE PLATING.

times the gauges for thicker than 22 gauge. Closer bends than these will cause cracking on the outside of the bend and a greater tendency to corrode in service.

Internal Stiffener

After the new frame section is made, an internal stiffener of the same section or shape is made up to sit snugly inside both the new and the old portion and should be long enough to reach either to the top or the bottom of the frame. This will form a strap joining the old and new sections together. The pitching and size of the rivets in the stiffener will be the same as that securing the frame to the plating and should be kept close to the bends in the section. It will be seen that cutting the butt joints in the repair at an angle will make a stronger job than would be obtained in cutting them square.

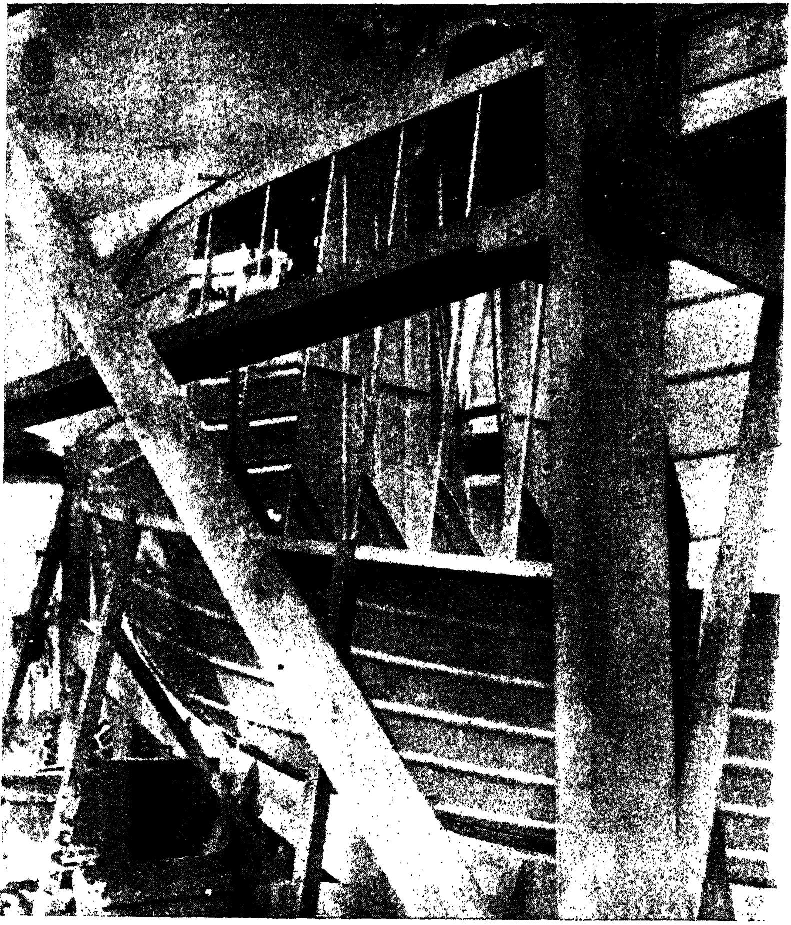


Fig. 25.—SUPPORT FOR KEELSON AND CHINE WHEN RENEWING PLATING.

In repairs such as this it is often difficult to hold up the rivets when hardening up. Pan-headed rivets will then be used.

If the frame is extensively damaged, it may be found quicker to remove that section complete, and renew. The frames themselves are normally built up of a deck member, two side members and two floor plates or members. Any one of these can be replaced independently of the others.

When Plating is Slightly Buckled

Should a section of plating be slightly buckled and the adjacent frames also, the removal of the affected plate will often allow the frames

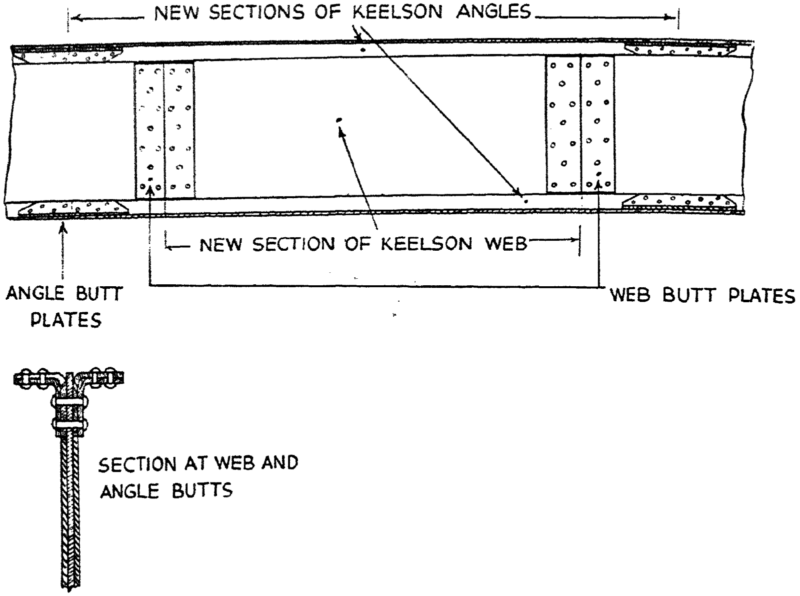

NEW SECTIONS OF KEELSON ANGLES
NEW SECTION OF KEELSON WEB
ANGLE BUTT PLATES
WEB BUTT PLATES
SECTION AT WEB AND ANGLE BUTTS

Fig. 26.—Details of repairs to keelson.

to spring back to their original shape. In this case the plate only need replacing. This may also be found to happen when the keelson web is only slightly buckled. If the buckling remains, however, and is only slight, it should be dressed out as far as possible by using hardwood blocks and an anodised duralumin plate fitted to either side of the keelson web, the whole being secured by suitably spaced 2BA or $\frac{1}{4}$ in. bolts, nuts and washers. Riveting in this region is usually impossible on a finished boat or float.

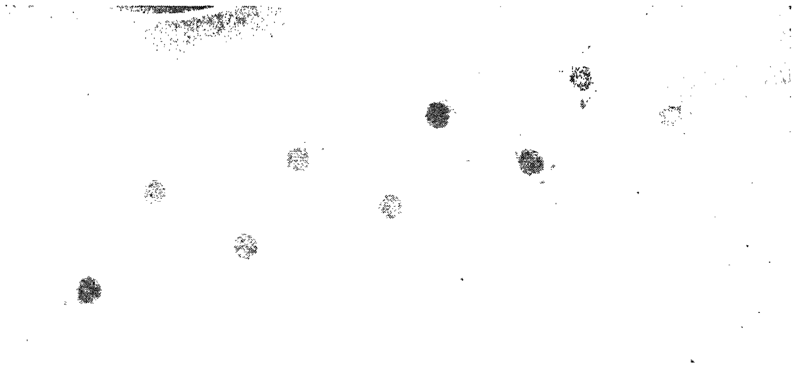


Fig. 27.—Burrs should be removed from holes before riveting up.

Keelson Badly Buckled or Fractured

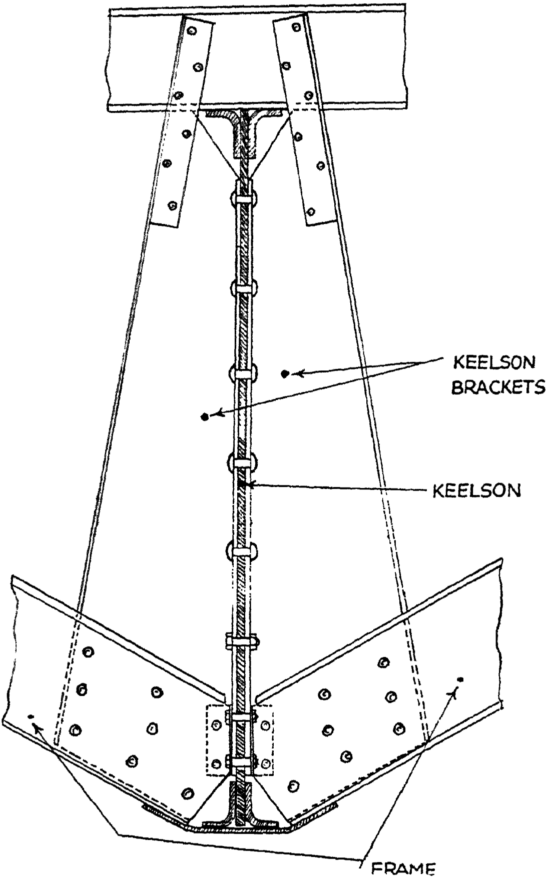


Fig. 28.—How the frames are attached to the keelson.

Should the keelson be badly buckled or fractured, it will entail placing the structure on a saddle to suit that particular hull. As the frames and plating in that region will buckle with the keelson, the bottom plating will have to be removed. The buckled portion is cut out and a new web section cut to fit. The top and bottom keelson angles or bars will be cut out also about 2 in. further back to allow the new angles to overlap the butt joints in the web. After placing the new section of web in position, the new angles are riveted up.

Butt straps are then made of the same gauge and material as the web, to overlap the joints in the latter by 1½ in. on either side, and secured by treble rows of rivets at ⅝ in. pitch, using rivets of ¼ in. diameter. Small butt straps or angles will also be fitted to joints in the keelson angles.

Removal of all burrs before riveting up is important when carrying out repairs and no swarf or shavings should be allowed to remain between jointing faces. All new sections should also be thoroughly protected after being drilled and before riveting up.

In the case of a float or hull employing snap-headed rivets, it may be difficult to hold the head up squarely, in which case pan-headed rivets are used, but this is confined as much as possible to internal riveting. With flush-riveted structures, care is necessary when removing rivets, as cracks will readily start at the holes. No attempt should be made to dress the

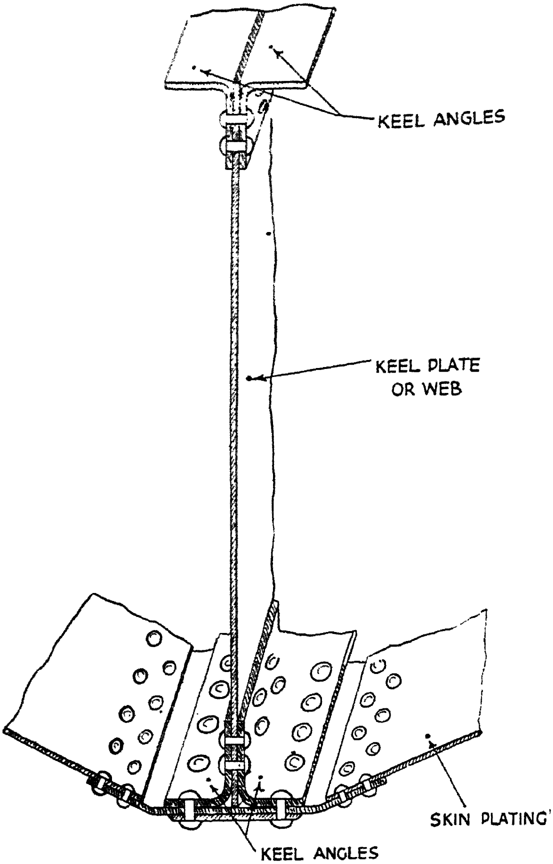


Fig. 29.—How the plating is attached to the keelson.

plating out where it is draw-sunk, as this is sure to start cracks. If the holes are stretched it is far better to fit the next sized rivet. This type is removed from the inside of the structure, of course, in all cases.

Dents in Hull Plating

If the hull plating is corrugated, as in some types, to give additional stiffness to the skin plating, it will be found that those in the forward plating may easily become dented. This is not serious providing it is local, but where it extends over a considerable length it should be dressed out by means of shaped hardwood blocks, and. if any signs of cracking are evident, a corrugated patch plate should be fitted by means of a single row of rivets at 1 in. pitch.

Generally speaking, local indentations are more important on a stressed skin structure than on the type where the plating is only partially stressed. The former type can be identified by the fact that the hull frames are cut away where the fore and aft plating formers or stiffeners occur, whereas in the latter the frames are not cut away.

"Flats" in the Forward Planing Bottom

If "flats" are formed to a large extent in the forward planing bottom, this may affect the behaviour of the hull or float during landing or taking off. They usually form in between the attachment points of the plating to the frames, without deformation of the latter. These can often be

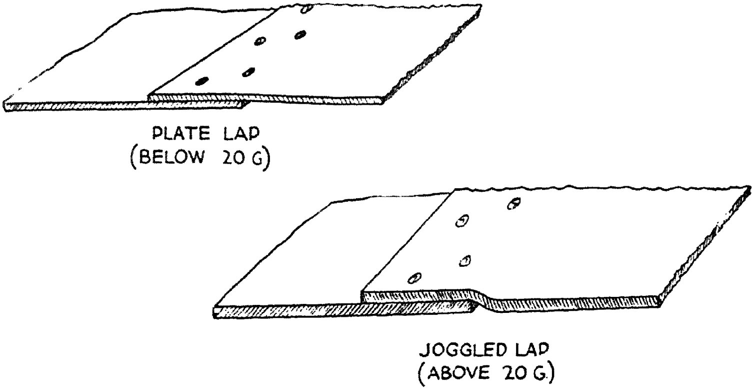


Fig. 30.—Details of plate laps.

remedied by holding up on the outside of the structure at the frame flanges and dressing the plate from the inside with a large flat wooden pad or block. Two or three "Zed" or angle section fore and aft stiffeners riveted to the inside of the affected plates and butting up close to the frame flanges will prevent further flats being formed. These stiffeners should be approximately 8 in. apart.

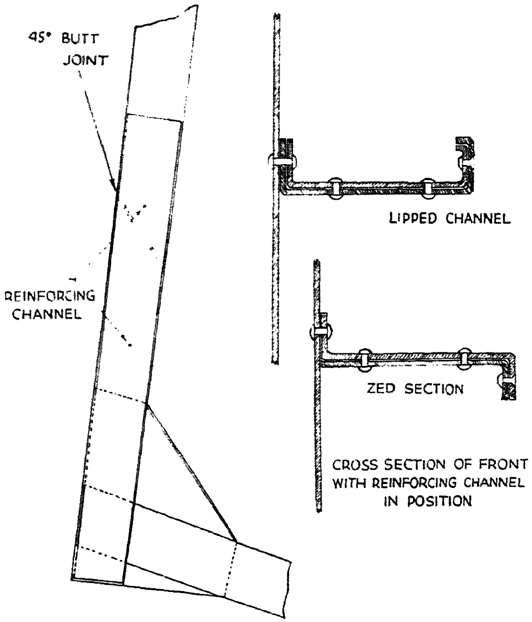


Fig. 31.—Method of repairing side members of main frames.

A Note on Plate Laps

A point to remember when carrying out repairs is that, in all plate laps, the upper overlaps the lower and the front plate overlaps the rear. When the plating is holed at a lap joint, the patch plate must be joggled to allow it to sit down snugly. This is a simple matter if suitable blocks are available. In the event of being unable to do this, a small packing plate of

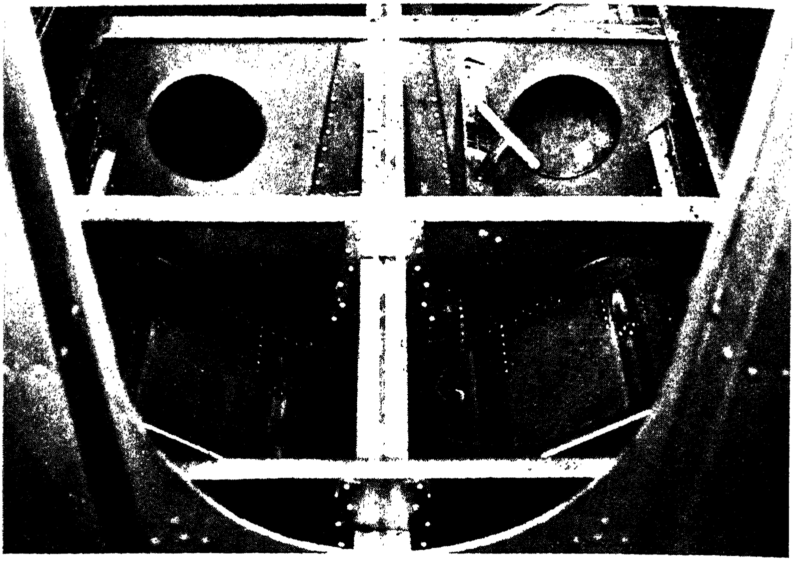


Fig. 32.—THE FLANGED LIGHTENING HOLES.

the same gauge as the plating is made, this butting up against the existing plate. The patch plate is then fitted and riveted up in the usual way.

Replacing Gusset Plates and Stiffeners

Gusset plates and stiffeners in hull and floats are often provided with flanged lightening holes. Should it be necessary to replace one of these, due to a failure, the plate must be heat-treated after cutting the hole and before forming the flange. Should no facilities be available for doing this, the detail should be made up, deleting the flanging of the hole and giving it the

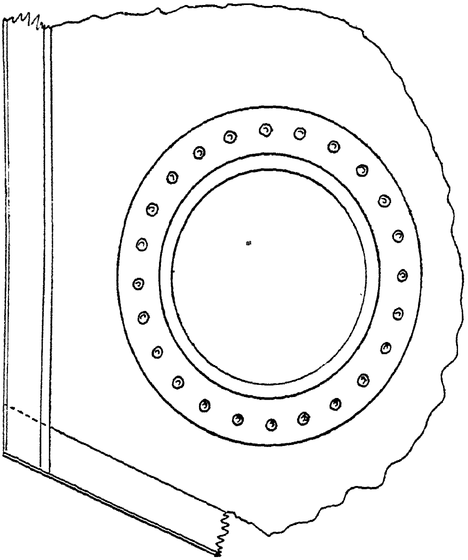


Fig. 33.—METHOD OF REPAIRING DAMAGED LIGHTENING HOLES IN FRAMES AND GUSSETS.

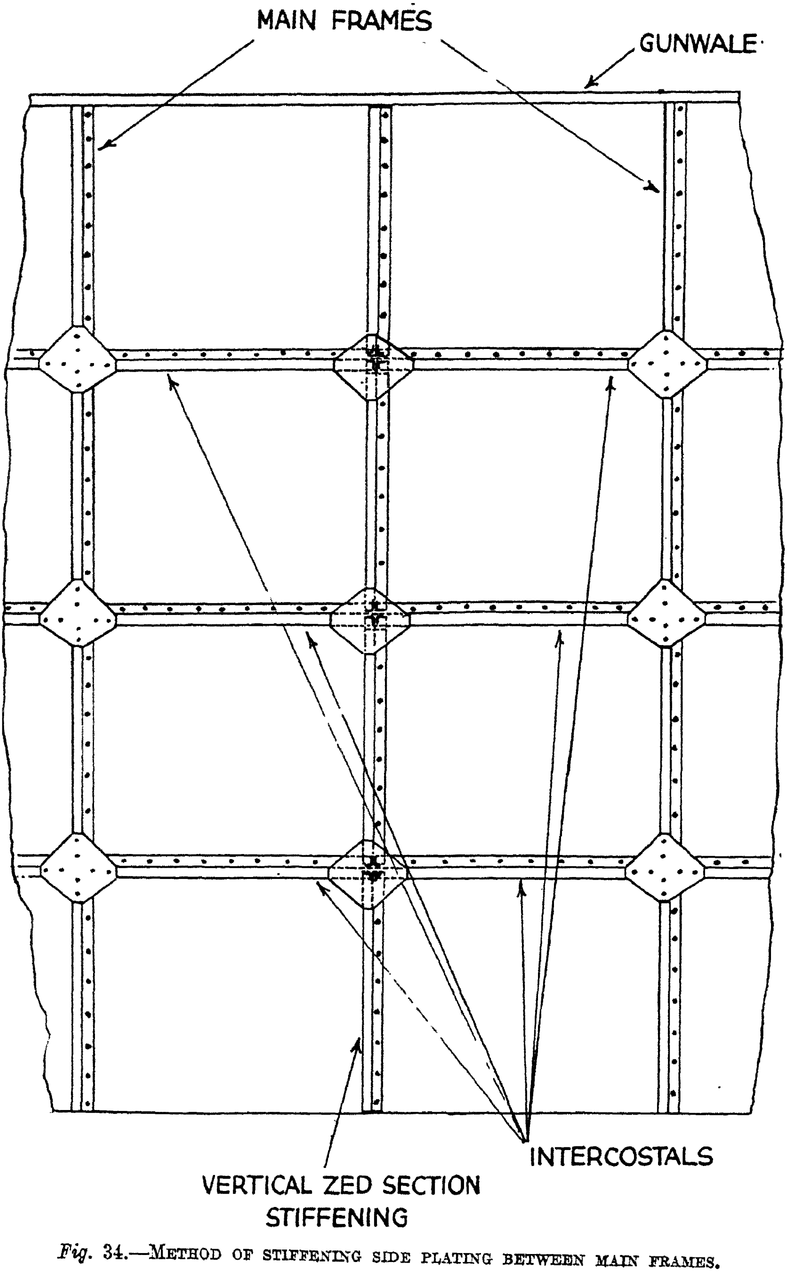


Fig. 34.—METHOD OF STIFFENING SIDE PLATING BETWEEN MAIN FRAMES.

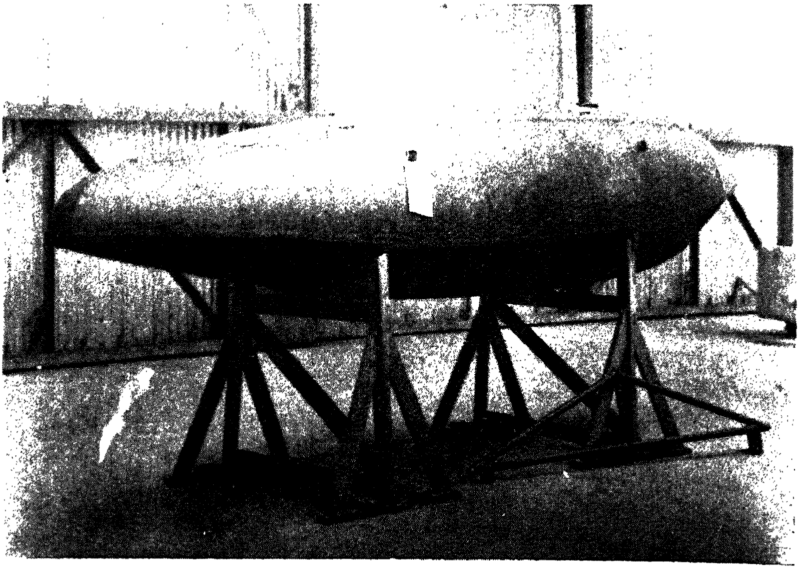


Fig. 35.—ATTACHMENT STRUT PIN CENTRES SHOULD BE CHECKED AFTER EXTENSIVE FLOAT REPAIRS.

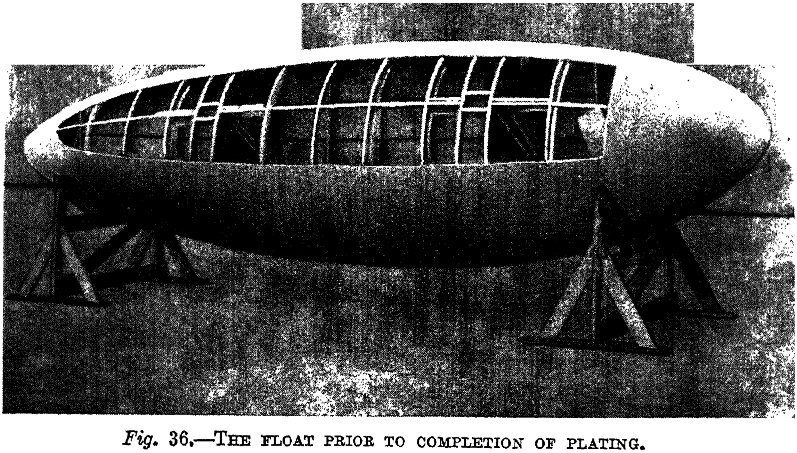


Fig. 36.—THE FLOAT PRIOR TO COMPLETION OF PLATING.

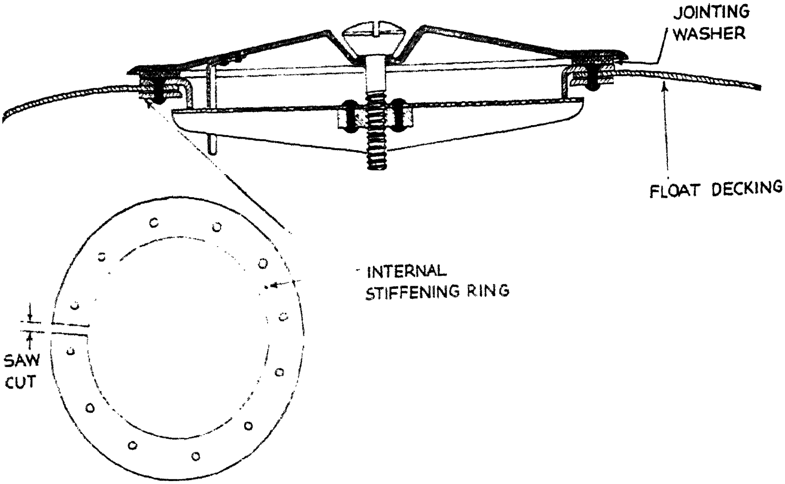


Fig. 37.—Type of inspection door.

required strength by attaching two light "Zed" or angle-section stiffeners across the hole by means of single line $\frac{1}{8}$ in. rivets. These angles should be attached on the side which would normally have the flanging.

These flanges in both frames and stiffeners may sometimes crack to their full depth. In such cases as this, the flanging should be completely filed out, leaving a clean hole. A flanged ring is then made up and

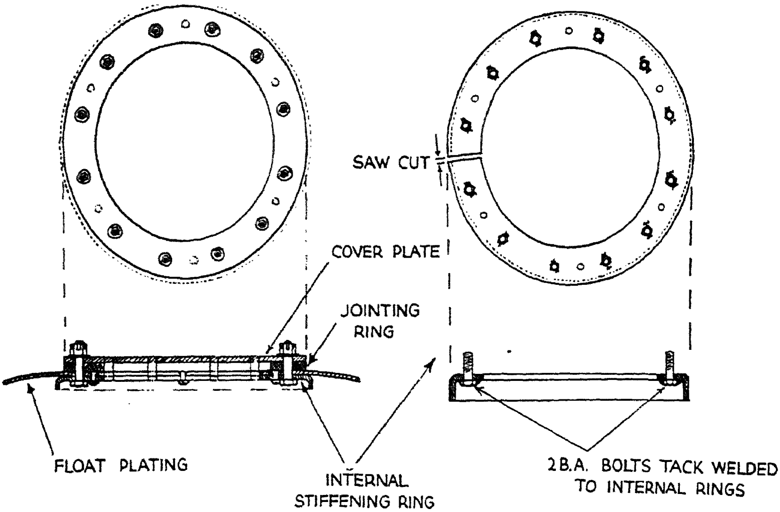


Fig. 38.—Method employed in providing additional hand-hole or inspection door.

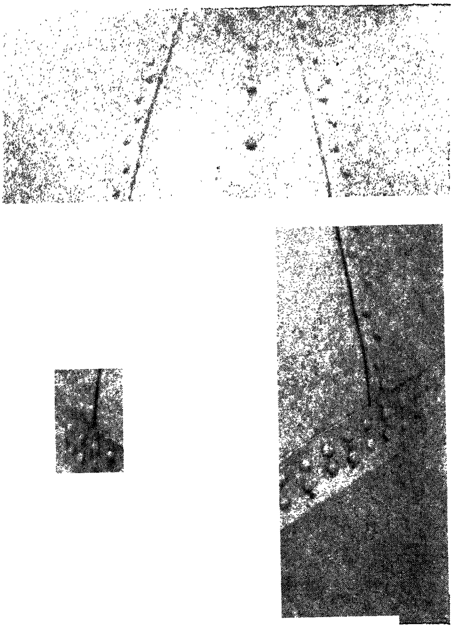


Fig. 39.—THE FLOAT HEEL PLATE AFTER RIVETING.

inserted in this hole and secured by a single row of rivets at approximately ¾ in. pitch.

Internal Members

Internal members are often secured to the hull or float by means of tubular rivets. When these are used, the same heat treatment is necessary as for solid rivets. After spinning or forming the heads, they should be examined for cracks, any found being replaced. The shank of this type of rivet does not expand when the head is formed and the holes to receive them should be "size" holes. In the case of solid light alloy rivets, the holes may be drilled a clearance size, from 0·004 to 0·006 in. oversize to allow for this swelling of the shank.

Corrosion at Points of Attachment

Other places where repairs may be found necessary are at points of attachment of the tail unit, strut fittings and such like, due to corrosion setting in around the steel fittings. If this is serious, the section of plating will need replacing, but if slight, the corrosion should first be removed by a thorough brushing and protected by two coats of pigmented oil varnish, with a finishing coat of aluminium lacquer. A large patch plate should then be made of the same gauge and material as the plating and attached, after coating with marine glue, by means of suitably spaced rivets. The size of the patch plate should be such that the load is spread over a fairly large area of sound plating. The holes for the attachment fittings can be found from the original plating.

Floats

Floats are usually provided with a number of hand-holes to give access to the interior. The former, however, may sometimes be damaged in such a way that the affected point is not accessible through the hand-holes provided. An additional hand-hole will then have to be cut to enable the repair to be made. This should be cut in the deck plating and must be reinforced by an internal stiffening ring, flush-riveted to the plating. The ring will have to be cut through one side to allow it to be entered through the hole. A standard hand-hole cover is then fitted. Pan-headed rivets are invariably used for float repairs owing to the limited space and hardened up on the outside.

Should repairs be necessary at such points as the fin plating where the plating is curved, these are usually possible, providing the patch required is small and the curvature is simple. If complete plates have to be removed they will need final heat treatment and shaping to the correct contour before fitting; this cannot usually be done while the aeroplane is in service.

Simple right-angle bends can be made without softening the material, providing the bend radii are kept within the correct limits. When replacing sections of frames, gussets, stiffeners, etc., the flanging of the members should face in the same direction as the original.

It will be found that main frame attachment flanges at the plating face towards the main hull or float step. After carrying out repairs, the structure should be water tested as for new hulls or floats.

A thick red line painted around the interior of the hull or float at the loaded water line is of assistance, should the aeroplane be holed when taking off from the water.

When extensive repairs are necessary at heavily stressed points, such as the main spar frames or the keelson, it is advisable to apply to the manufacturers of the hull or float, who will supply a repair scheme to suit a particular case. The advantage of this is that the stressing of the repair scheme is approved before the work is carried out.

THE DE HAVILLAND "DRAGONFLY"

(TYPE D.H. 90)

By A. J. BRANT, *Service Manager, de Havilland Aircraft Co. Ltd.*

THE de Havilland " Dragonfly " aeroplane is a successful production type, large numbers of which are in world-wide use, but its unusual type of construction has influenced its inclusion in this series of articles.

The " Dragonfly " may be classified as a " semi-cantilever biplane."

The well-tried braced biplane has been used as a basis of the design with an ingenious use of cantilever structure where special advantages have been gained.

The centre section of the lower plane is a true cantilever, and the spars being of great depth, make a thick wing, which conveniently accommodates the main fuel tanks, and all loads in the air and on the ground are centralised in these members. This has resulted in low structure weight, rigidity, compactness and manœuvrability of the biplane with an extremely clean effect. The tapered wing is not only highly efficient, but very light in proportion to its strength.

The " Dragonfly " introduces a new conception of comfort and silence into air travel. The cabin accommodates five, two in front, with the pilot on the left, two on a spacious seat extending right across the back of the cabin and one in an armchair on the right side opposite the door, so that access to all seats is convenient.

The cabin is 10 ft. long from rudder bar to rear, 5 ft. high and more than 4 ft. wide. Each passenger has, therefore, 40 cu. ft. of space.

A new system of sound-proofing is used, allowing easy conversation and minimising noise fatigue.

Either cool air from individual adjustable ventilators, or warm air from engine exhaust muffs, can be admitted at will.

Windows of non-splintering composition run the whole length of the cabin, providing a perfect view.

A shelf for light articles is situated at the extreme rear of the cabin and a luggage locker of 28 cu. ft. capacity behind is reached by an outside door on the starboard side.

The pilots, whose chairs are easily accessible through the space between them, have an excellent outlook which makes navigation easy.

A central control column carries, on a fixed branch to the left, a segmented wheel or " spectacles " for the pilot. Two rudder bars are provided, and if the second pilot is to share the flying, a stick with a spade grip can be quickly plugged in as a right-hand branch.

Throttle and mixture controls are on the left and both levers are of specially long reach for ease of fine adjustment and synchronisation.

A tail-trimming lever and small handle for rudder bias, both operating spring tension gear, are placed within reach of both pilots. The aeroplane can thus be trimmed for any loading condition and the pilot relieved of all rudder effort, even if one engine should be completely out of action.

A convenient lever operates the split flaps, which take the "edge" off the glide and give greater lift for easy approach and slow landing.

The wheel brake lever is of a new type and protrudes from the dashboard. It applies the brakes together, and when left partly on brings them under differential control by the rudder bars for steering on the ground.

A high degree of ease and responsiveness in the controls has been achieved which eliminates fatigue on long journeys and the flap gear removes all difficulty from the landing.

With full load, the "Dragonfly" has a ceiling of 2,100 ft. on either engine alone and this figure naturally improves as fuel is consumed.

The airscrews fitted as standard are of wooden construction finished with the "Schwarz" protection.

The standard equipment includes everything necessary for operation in all weathers over any distance. In addition to the airspeed indicator and altimeter, the "air side" includes an artificial horizon and directional gyro, chosen as standard for the natural ease which they introduce into blind flying.

On the "engine side" are two electric r.p.m. indicators, two oil pressure gauges, and air log and a fuel gauge for each of the three tanks.

For navigation, there are a Huson Mark IIIA compass and an eight-day clock.

The instruments (luminous and/or illuminated) are all scientifically grouped on the dashboard and are visible from both front seats.

For the starter motors on the engines an accumulator is carried in a separate but accessible compartment in the luggage locker. It is charged by a wind-driven generator and supplies the navigation and dashboard lights as well as the landing light in the nose of the fuselage. All these are standard fitments and make the "Dragonfly" independent of ground facilities for night flying and night landing.

Engines

The engines fitted to the "Dragonfly" are two 130 h.p. "Gipsy Major," four-cylinder-in-line, air-cooled units.

General Data

Weights	lb.
Tare weight (including standard removable equipment)	2,500
Pilot	170
Passengers—four at 160 lb.	640
Fuel, normal, 60 gallons	462
Oil, 7 gallons	68
Luggage	160
Total all-up weight	4,000

Note. The aeroplane is fitted with 85 gallons fuel tankage as standard—when the tank is full the pay load will be reduced by 193 lb.

Dimensions

Length overall	31 ft. 8 in.
Span (upper main plane)	43 ,,
Span (lower main plane)	38 ,, 6 ,,
Height	9 ,, 2 ,,
Wheel track	10 ,, 8 ,,
Engine centres	10 ,, 8 ,,
Top wing incidence	2°
Bottom wing incidence	2°
Top wing dihedral	3° 30′
Bottom wing dihedral	4° 30′
Wing area (including body)	288 sq. ft.

Performance

Loaded to 4,000 lb.

Note. All performance figures quoted are based on the most accurate possible tests carried out in England and reduced to International Standard Atmospheric Conditions. It must be borne in mind that local conditions of temperature, humidity and barometric pressure have an important influence on performance.

Maximum speed (at sea-level)	144–147 m.p.h.
Cruising speed—	
At 1,000 ft. and 2,100 r.p.m.	127–130 m.p.h.
At 1,000 ft. and 2,050 r.p.m.	122–125 m.p.h.
Cruising fuel consumption at 2,050 r.p.m.	12 galls./hr.
Ultimate range—	
With 60 galls. at 2,050 r.p.m.	625 miles.
With 85 galls. at 2,050 r.p.m.	885 miles.
Take-off run in 5 m.p.h. wind	295 yds. ± 30 yds.
Height at 656 yds. from rest in 5 m.p.h. wind	110 ft. ± 15 ft.
Distance to standstill from altitude of 50 ft. in 5 m.p.h. wind	340 yds. + 30 yds.
Gliding angle—flaps up	1 in 10½.
,, ,, —flaps down	1 in 8.
Rate of climb at sea-level	775 ft./min.
Time to climb to 5,000 ft.	7·5 min.
,, ,, 10,000 ft.	19·5 ,,
Absolute ceiling	16,000 ft.
Service ceiling	15,700 ft.

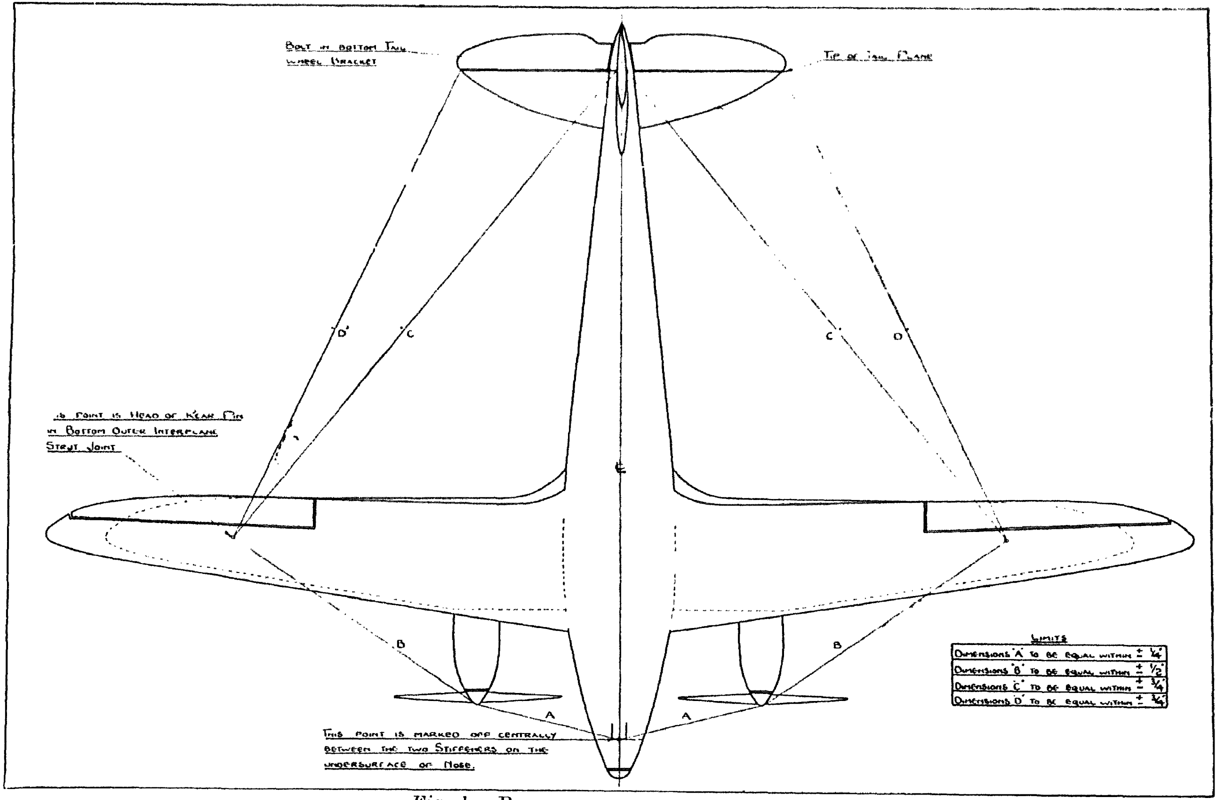

Bolt in Bottom Tail Wheel Bracket
Tip of Tail Plane
is Point is Head of Rear Pin in Bottom Outer Interplane Strut Joint
D'
C'
C
D
℄
B
B
A
A
This point is marked off centrally between the two Stiffeners on the undersurface of Nose.
Limits
Dimensions 'A' to be equal within ± ¼"
Dimensions 'B' to be equal within ± ½"
Dimensions 'C' to be equal within ± ¾"
Dimensions 'D' to be equal within ± ¾"

Fig. 1.—PERMISSIBLE LIMITS OF ERROR.

Ceiling on one engine—

On full load	2,100 ft.
Laden to 3,750 lbs.	3,800 ,,
Laden to 3,500 lb.	5,400 ,,
Laden to 3,250 lb.	7,400 ,,
Laden to 3,000 lb.	9,500 ,,

Note. The figures quoted should be regarded as the most accurate estimate it is possible to make and used as a guide only.

CONSTRUCTION OF THE "DRAGONFLY"

The "Dragonfly" is a twin-engine, two-bay biplane, comprising top main plane, bottom stub and bottom outer plane. These components consist of I-section spars, reinforced with packings where necessary, with spruce leading edge and ribs, whilst the trailing edges are of steel tube clipped to the ribs. The leading edges and tips of the planes are ply covered.

The interplane drag struts are of steel tube, the lugs for the swaged rods and high-tensile steel wire bracing being integral with the tube, making a structure which is not affected by any slight shrinkage which may take place in the wooden spars

In the first bay of the top plane a diagonal bracing tube is fitted which takes both compression and tensile loads.

The bottom stub spars pass across the cabin floor and are bolted to fittings on the bottom longerons and fuselage diagonal members.

The inner interplane struts are of tubular steel in the form of an inverted "V," and are welded together at the upper end. The lower ends are fitted to the front and rear spars, and the upper end is fitted to the front spar of the top plane.

Incidence adjustment on the top plane is by means of a small pin-jointed strut fitted between the rear spar of the top plane and a lug which is welded to the "V" strut near its upper end. There is also a screw adjustment at the lower end of the rear member of the "V" strut at the spar attachment.

The outer interplane strut is also of steel tube and is connected to both front and rear spars. This strut also has an incidence adjustment at its ends.

Interplane bracing wires are only used in the plane of the front spars in the outer bay.

The undercarriage loads are taken by the substantial spars of the stub plane and no interplane bracing in the inner bay is used.

Tail Unit

The tail plane consists of spruce spars stiffened with spruce ribs and leading edge, the whole being covered with 1½ mm. 5-ply to give torsional stiffness.

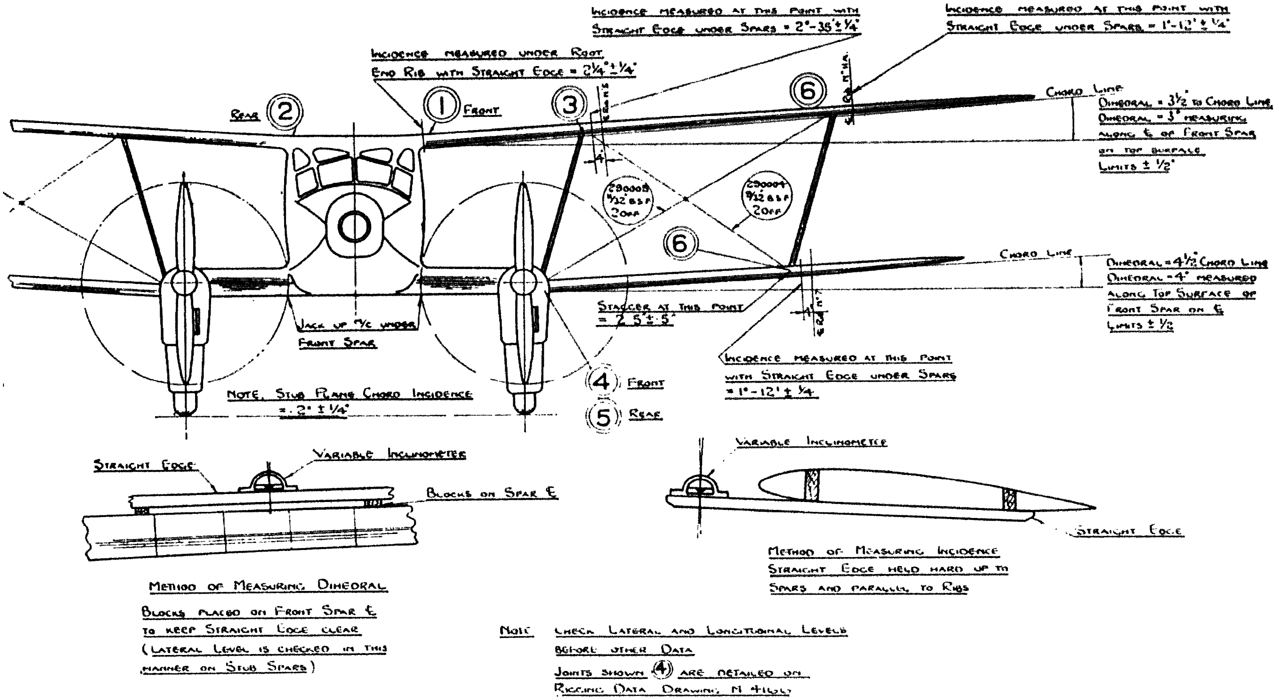

Incidence measured at this point with Straight Edge under Spars = 2°-35' ± 1/4°
Incidence measured at this point with Straight Edge under Spars = 1°-12' ± 1/4°
Incidence measured under Root End Rib with Straight Edge = 2¼° ± ¼°
Rear ②
① Front
③
⑥
Chord Line
Dihedral = 3½° to Chord Line
Dihedral = 3° measuring along ℄ of Front Spar on top surface
Limits ± ½°
290005 9/32 B.S.F. 2 off
290004 9/32 B.S.F. 2 off
⑥
Chord Line
Dihedral = 4½° Chord Line
Dihedral = 4° measured along Top Surface of Front Spar on ℄
Limits ± ½°
Jack up A/C under Front Spar
Stagger at this point = 2.5" ± .5"
Incidence measured at this point with Straight Edge under Spars = 1°-12' ± ¼
Note. Stub Plane Chord Incidence = 2° ± ¼°
④ Front
⑤ Rear
Straight Edge
Variable Inclinometer
Blocks on Spar ℄
Variable Inclinometer
Straight Edge
Method of Measuring Dihedral
Blocks placed on Front Spar ℄ to keep Straight Edge clear
(Lateral Level is checked in this manner on Stub Spars)
Method of Measuring Incidence
Straight Edge held hard up to Spars and parallel to Ribs
Note Check Lateral and Longitudinal Levels before other Data
Joints shown ④ are detailed on Rigging Data Drawing M 4160

Fig. 2.—RIGGING DATA FOR D.H. "DRAGONFLY" (D.H. 90).

The fin is constructed on the same lines as the tail plane, the ply skin in each case being covered with doped-on fabric.

The tail plane and fin are not wire-braced and rely on the ply skin for torsional stiffness. Hence it is important that the aeroplane should not be flown with the ply seriously damaged.

The elevator and rudder are constructed of spruce spars braced with diagonal ribs arranged to take torsional loads. The trailing edges are of steel tube clipped to the ribs with dural clip which are riveted and screwed on. Both elevator and rudder are fabric-covered and doped. The left and right elevators are coupled together at the centre by two channel fittings, to which the control lever is bolted.

The rear spar of the tail plane is rigidly fixed to the rear bulkhead of the fuselage by means of a steel fitting on either side of the fin post which is bolted to the centre of this bulkhead. The front spar of the tail plane is bolted to lugs which project from the ply skin of the fuselage. These lugs are bolted to a bulkhead inside the fuselage. The front spar of the fin is also bolted to this bulkhead at the top and bottom.

The tail plane and fin are thus rigidly fixed and no movement is possible. The tail trimming is accomplished by means of a differential spring gear on the elevator controls. This arrangement has a special control lever in the cockpit which is fitted with a ratchet in order that varying degrees of trimming can be obtained. The trimming gear is of a similar type for the rudder and is controlled by a small handle which projects from the control-box side.

Fuselage

The fuselage is a plywood monocoque structure. It consists of four spruce longerons which traverse the whole length of the fuselage.

These longerons are supplemented by longitudinal spruce stringers supported by transverse frames which are shaped to the contour of the fuselage.

The external ply is glued and bradded to this framework, thus forming a light but very rigid structure. The ply is finally covered with doped-on fabric. The fuselage is strengthened locally with packings and ply gussets at points where steel joint plates occur. The two frames at the rear end of the fuselage are substantial bulkheads since it is to these that the tail unit is fitted. The rear bulkhead also takes the tail-wheel loads.

The bolts at all joints are provided with cupped steel washers which allow for the natural shrinkage of the timber to take place without consequent loosening of the bolts.

The cabin is sound-proofed with "Cellacol," which is fitted between the ply skin and the upholstery. An emergency exit is provided in the roof above the rear seat. The control cables, after leaving the main control box between the pilots' seats pass between the ply skin and the cabin floor to their respective components.

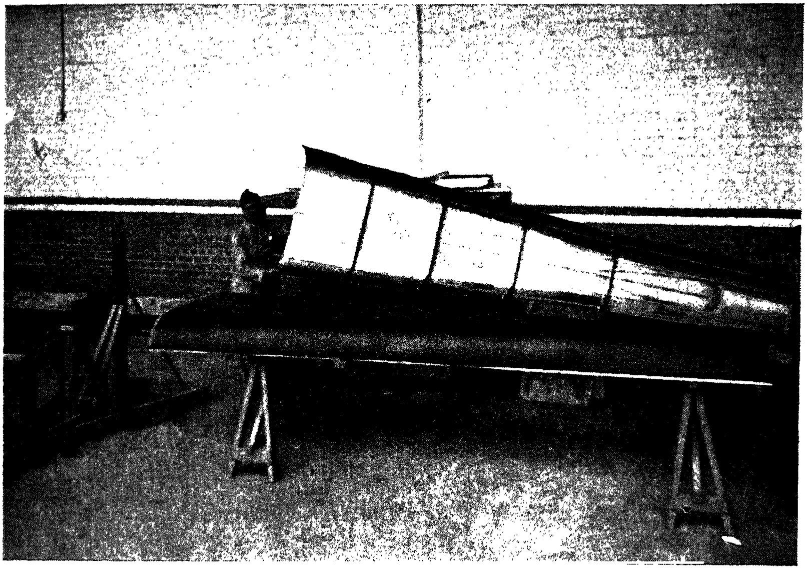


Fig. 2A.—THE SECTIONS FORMING TOP AND BOTTOM OF THE FUSELAGE ARE BUILT AS UNITS ON A JIG.

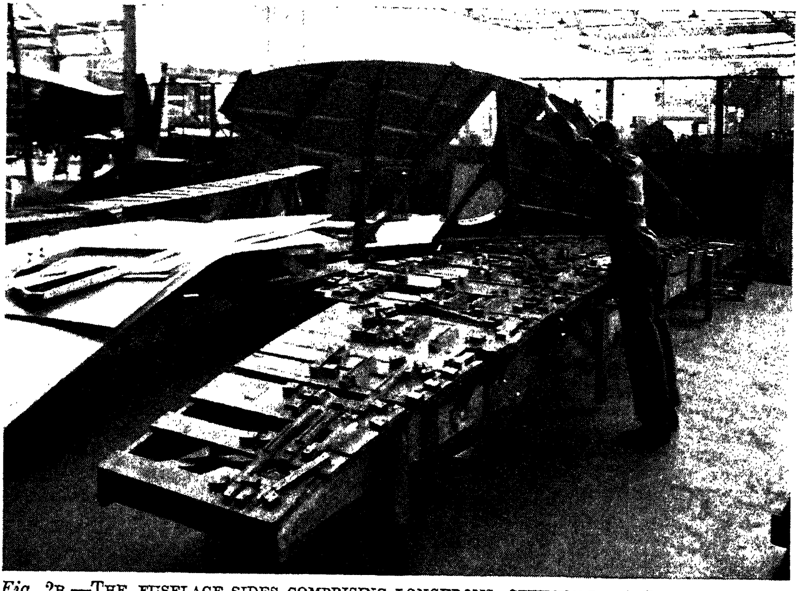


Fig. 2B.—THE FUSELAGE SIDES COMPRISING LONGERONS, STIFFENERS, AND SIDE PLY ARE BUILT FLAT IN JIGS.

The side is shown finished and being lifted off the jig.

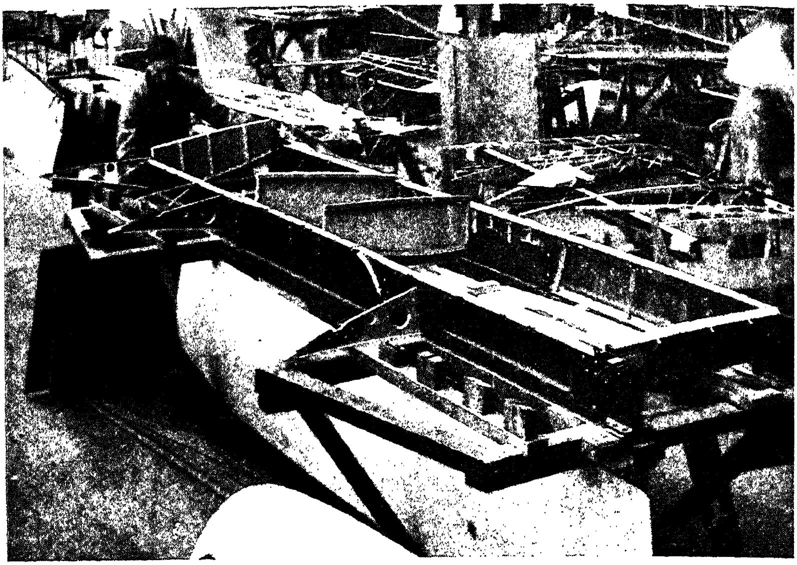


Fig. 2C.—THE BOTTOM CENTRE SECTION STUB PLANE IS BUILT TO A CERTAIN STAGE ON A JIG. THE MAIN SPARS ARE SHOWN IN THE JIG READY TO HAVE THE RIBS, ETC., ASSEMBLED.

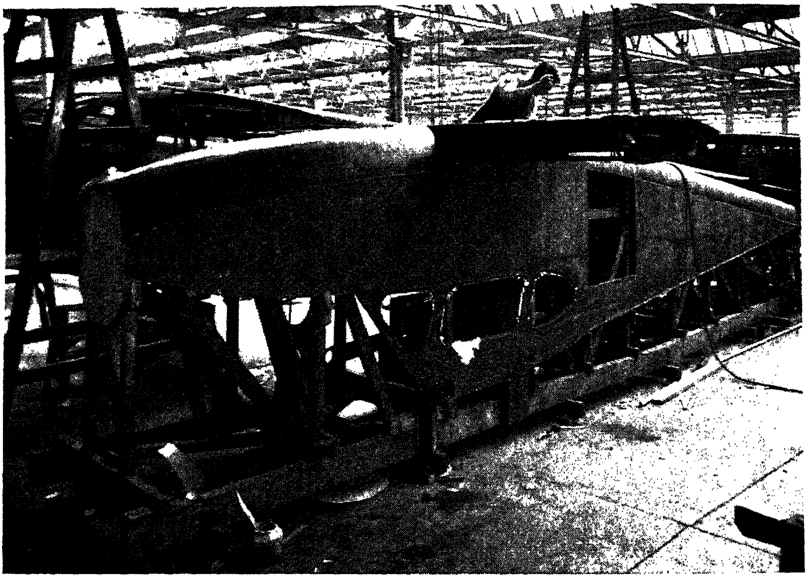


Fig. 2D.—THE FUSELAGE IS BUILT IN AN INVERTED POSITION ON THE MAIN ASSEMBLY JIG AND INCORPORATES THE BOTTOM STUB PLANE.

Engine and Tanks

Electric engine starters (type Rotax "Eclipse" Y. 150) are fitted which are operated from the normal starter battery by means of buttons situated on the instrument board. These buttons are protected by safety covers to obviate the possibility of accidental starting of the engines.

The mounting for the engine and oil tank consists of a tubular metal structure built into the bottom stub plane. This structure is fitted to the front spar by means of "U" bolts which have heavy steel springs under the nuts. The springs extend and take up any slack if the spar should shrink owing to the heat of the engines. A metal and asbestos fireproof bulkhead is fitted between the engine and the oil tank.

There are three fuel tanks fitted, one of 30 gallons in each stub plane and one of 25 gallons in the fuselage. The fuel for the engines is controlled from the cockpit by means of a remote control to a cock situated in the control box on the cabin floor.

The main tanks are constructed of aluminium with welded seams and held in position between the spars by straps covered with langite. The auxiliary tank is fitted beneath the rear seat in the cabin and is held in position by langite-covered metal straps.

Fuel is supplied by twin engine-driven diaphragm pumps on each engine. The carburetters are flooded by actuating a lever on the body of the pumps. The individual functioning of the pumps should be checked by flooding the carburetters with each in turn. It is important that the ply panel covering the main tanks be firmly bolted in position with all the bolts, since this panel is a part of the structure and takes the torsional loads.

The oil tank is of welded aluminium construction and is held in position behind the fireproof bulkhead with metal straps covered with langite. The oil tanks have an effective capacity of 3½ gallons and have an air space of approximately ½ gallon above the maximum oil level. Oil is supplied to the engine by means of an engine-driven pump and passes through a filter on the engine before entering the engine.

Undercarriage

The undercarriage consists of one wheel under each engine mounting attached to a rigidly braced structure, the only external moving parts being the piston tubes and fittings which slide in the outer casings of the compression legs. There are no hinged parts to move, consequently the points at which wear may occur have been reduced to a minimum. The wheel axles are supported at each end in trunnions with detachable caps, the axle ends being squared to take the brake torque. The shock absorption is taken by telescopic struts on each side of the axle with rubber blocks in compression and friction damping.

Dunlop wheels, A.1, 4·75–10 in. (7·5 in. tyre) are fitted as standard, and are encased in streamline fairings designed to improve the performance and appearance of the aeroplane in addition to keeping it clean.

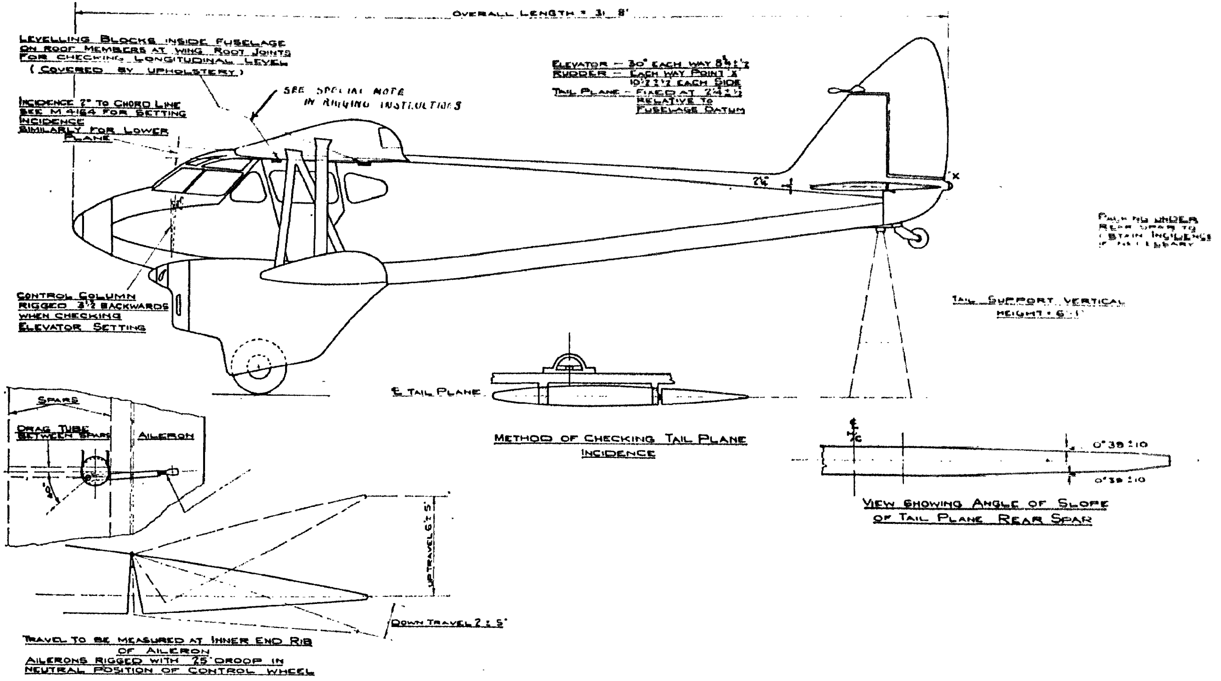

OVERALL LENGTH = 31' 8'
LEVELLING BLOCKS INSIDE FUSELAGE ON ROOF MEMBERS AT WING ROOT JOINTS FOR CHECKING LONGITUDINAL LEVEL (COVERED BY UPHOLSTERY)
SEE SPECIAL NOTE IN RIGGING INSTRUCTIONS
INCIDENCE 2° TO CHORD LINE SEE M.4164 FOR SETTING INCIDENCE SIMILARLY FOR LOWER PLANE
ELEVATOR — 30° EACH WAY 8¼ ± ½
RUDDER — EACH WAY POINT X 10⅞ ± ½ EACH SIDE
TAIL PLANE — FIXED AT 2¼ ± ½ RELATIVE TO FUSELAGE DATUM
2¼°
X
PACKING UNDER REAR SPAR TO OBTAIN INCIDENCE IF NECESSARY
CONTROL COLUMN RIGGED 3½ BACKWARDS WHEN CHECKING ELEVATOR SETTING
TAIL SUPPORT VERTICAL HEIGHT = 6' 1"
℄ TAIL PLANE
METHOD OF CHECKING TAIL PLANE INCIDENCE
℄ ½C
0°38' ± 10
0°38' ± 10
VIEW SHOWING ANGLE OF SLOPE OF TAIL PLANE REAR SPAR
SPARS
DRAG TUBE BETWEEN SPARS
AILERON
40°
UP TRAVEL 6⅞ ± 5'
DOWN TRAVEL 2 ± 5'
TRAVEL TO BE MEASURED AT INNER END RIB OF AILERON
AILERONS RIGGED WITH ·25' DROOP IN NEUTRAL POSITION OF CONTROL WHEEL

Fig. 3.—RIGGING DATA (SIDE VIEW) FOR D.H. "DRAGONFLY" (D.H. 90).

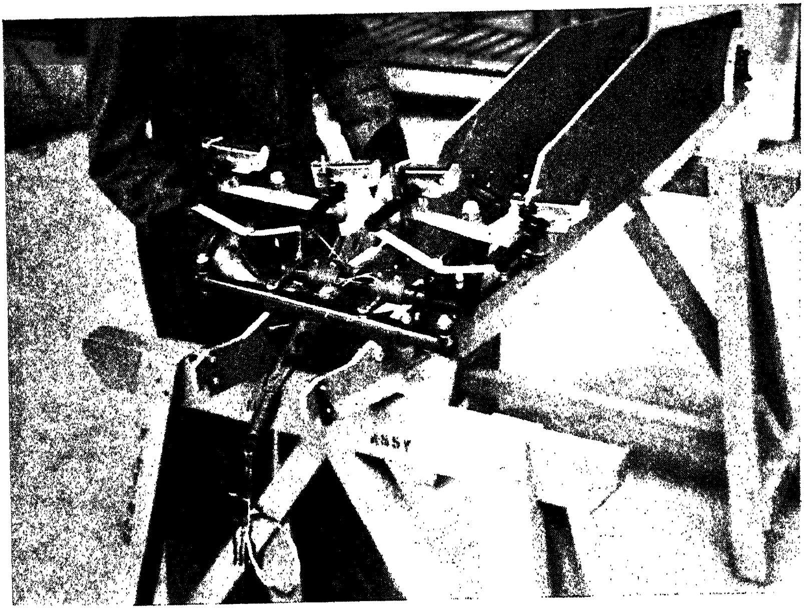


Fig. 3A.—THE PILOT'S CONTROLS ARE BUILT ON BEARERS AS A UNIT.

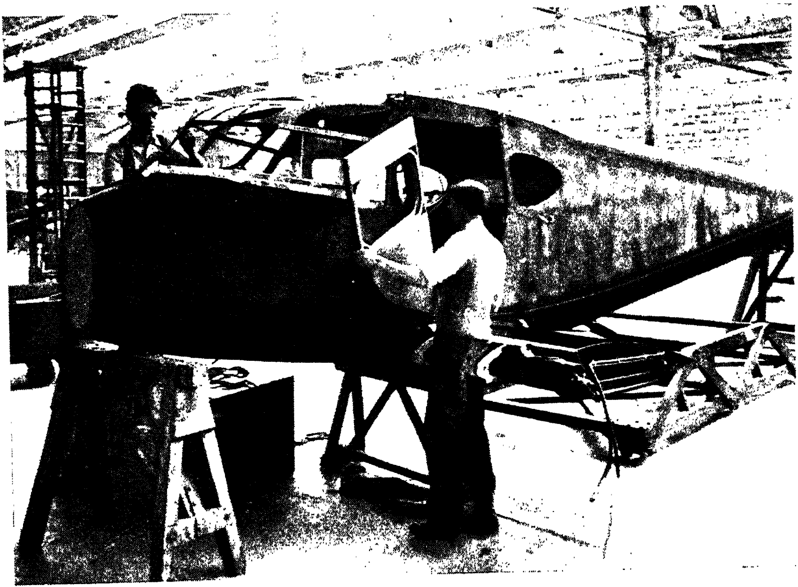


Fig. 3B.—THE FUSELAGE IS HERE SHOWN OFF THE MAIN ASSEMBLY JIG, AND THE FITTING OF WINDOW FRAMES, DOORS, ETC., IS PROCEEDING.

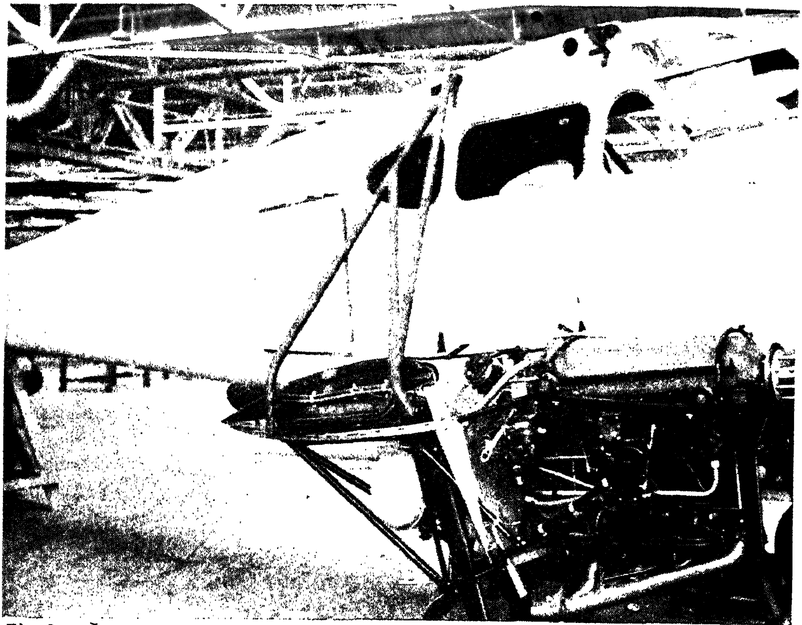


Fig. 3C.—IN PRODUCTION WORKS A TEMPORARY JURY STRUT IS FITTED TO PERMIT THE COMPLETION OF ENGINE INSTALLATION BEFORE FITTING MAIN PLANE, THUS SAVING FLOOR SPACE.

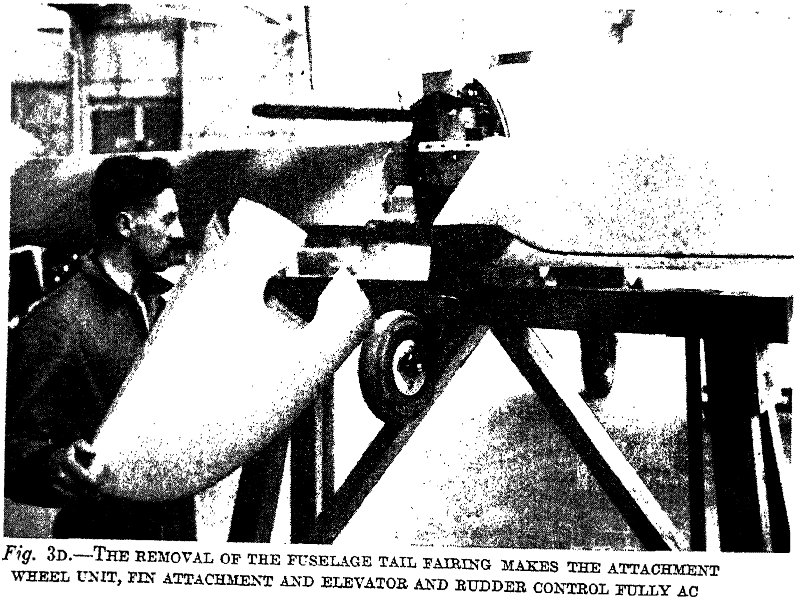


Fig. 3D.—THE REMOVAL OF THE FUSELAGE TAIL FAIRING MAKES THE ATTACHMENT WHEEL UNIT, FIN ATTACHMENT AND ELEVATOR AND RUDDER CONTROL FULLY AC

Tail Wheel

The tail wheel consists of a Dunlop "Ecta" 3–4-in. tail-wheel tyre and A.H. 207–10 in. × 3 in. wheel with full castor action. The shock-absorbing device consists of rubbers in compression encased in telescopic tubes. Particular attention has been paid to provide large bearing surfaces at moving points and lubricators for gun greasing are placed where necessary.

RIGGING THE "DRAGONFLY"

To assemble the aeroplane it is first necessary to support the fuselage on trestles. Longitudinal levels are now checked, using a straightedge on which packing blocks are placed sufficiently deep to give clearance for the level and the front block must be $1\frac{3}{16}$ in. deeper than the rear one to give the correct longitudinal rigging datum line. These blocks, together with the trestle points, are shown in Fig. 2. The lateral level is checked by placing a level on the spars of stub plane which is integral with the fuselage. The top plane is now attached to the root fittings on the fuselage and tip of the plane is supported in its approximate position. The "V" strut is fitted to the top plane and stub fittings and the outer interplane strut is suspended from the fittings on the top plane.

The lower plane is now attached to the stub fittings, and the interplane strut is connected up, the whole being supported by trestles to prevent the aeroplane tipping over. The interplane bracing wires are now fitted and tensioned up approximately, to form a structure whilst the opposite planes are rigged in a similar manner.

The engine mounting together with oil tank, fireproof bulkhead and undercarriage are now fitted so that they are suspended from the spars of the stub plane. The springs beneath the nuts on the "U" bolts which hold the engine structure to the spars must be fully compressed when assembled.

The engine is now fitted and controls, pipes, etc., connected up.

The aeroplane is now ready for trueing up and the levels, lateral and longitudinal, should be checked and reset if necessary.

To true up, the adjustment for incidence at the ends of the outer interplane strut is set in its mid-position. The interplane bracing is then adjusted to give the correct dihedral.

The correct incidence is now obtained by adjustments to the lower end rear member of the "V" strut with tie rod and the adjustment on the ends of the outer interplane strut previously mentioned.

The dihedral must now be rechecked as the outer interplane strut adjustment affects the dihedral since it is on the forward end of the strut.

The trueing up must be carried out with the engine in position as the rear adjustment of the "V" strut is affected by the overhanging weight.

For general information the rigging diagrams, Figs. 2 and 3, can be consulted, but the actual angles to which a particular aeroplane as passed

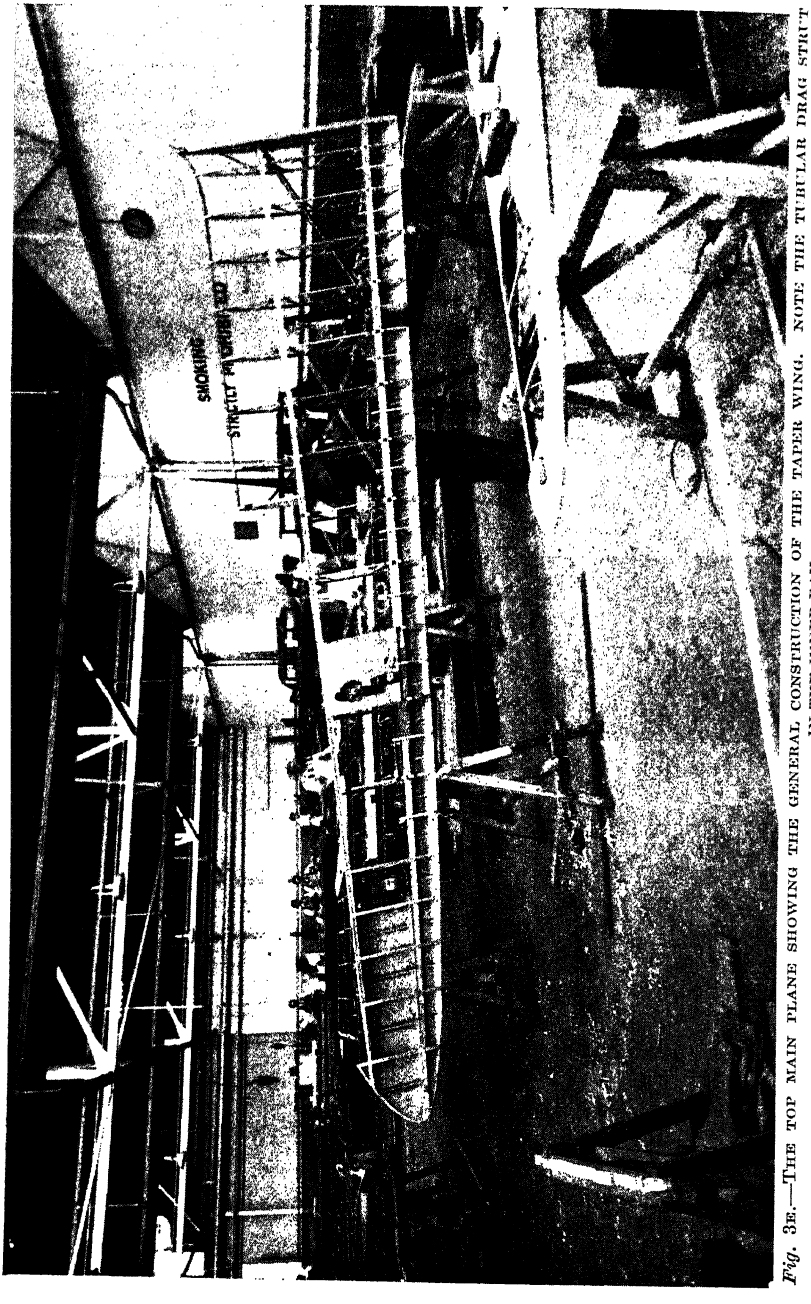


Fig. 3E.—THE TOP MAIN PLANE SHOWING THE GENERAL CONSTRUCTION OF THE TAPER WING. NOTE THE TUBULAR DRAG STRUT IN THE INNER BAY.

out by the constructor are given in the Log Book and these latter should be used.

The main fuel tanks are strapped down in the stub planes and the pipe lines are connected up.

The covers for the tanks are then carefully bolted in position, care being taken to see that all the bolts are in.

The aeroplane can then be lowered on to its wheels.

To Remove Top Plane

The fuselage is supported on trestles and a jack arranged under the engine. The main planes are then supported on trestles at the tips and the bracing wires removed. The attachment fittings at the "V" strut on the stub are released and the root fittings on the upper plane are disconnected. Both planes, together with struts, can then be removed. To enable the bolts in the fittings to be easily withdrawn the jack under the engine can be adjusted.

On no account must the jack under the engine be removed whilst the top main plane is not in position with the "V" strut.

To replace reverse the process.

Summary of Notes

1. Engine (and undercarriage) can only be suspended from the stubs when the top main plane is in position with the "V" strut.
2. The aeroplane can only rest on its wheels when the top main plane is in position with the "V" strut.
3. In all other cases of fitting engines, tanks or rigging, the engine must be supported.

Care should be taken when rigging to ensure that the flying and landing wires are not over-tensioned to the extent of bowing the main plane spars. It will be appreciated that large wires can be tightened to an excessive degree, far in excess of that required to obtain correct rigging. If any difficulty is experienced the rigging is probably at fault and a careful check should be made throughout.

Tail Unit

The fin is fitted to the fuselage by passing the front spar projection through the appropriate hole in the top skin of the fuselage and bolting it to the bulkhead inside, at the top and bottom. The fin post is then bolted to the rear bulkhead of the fuselage. The tail plane is fitted by bolting the rear spar to the fittings on either side of the fin post on the rear bulkhead of the fuselage, while the front spar is attached by means of bolts to the projecting lugs from the fuselage side. These lugs are carried on the same fuselage bulkhead to which the front spar projection of the fin is fitted. The rear spar fittings are situated lower than the

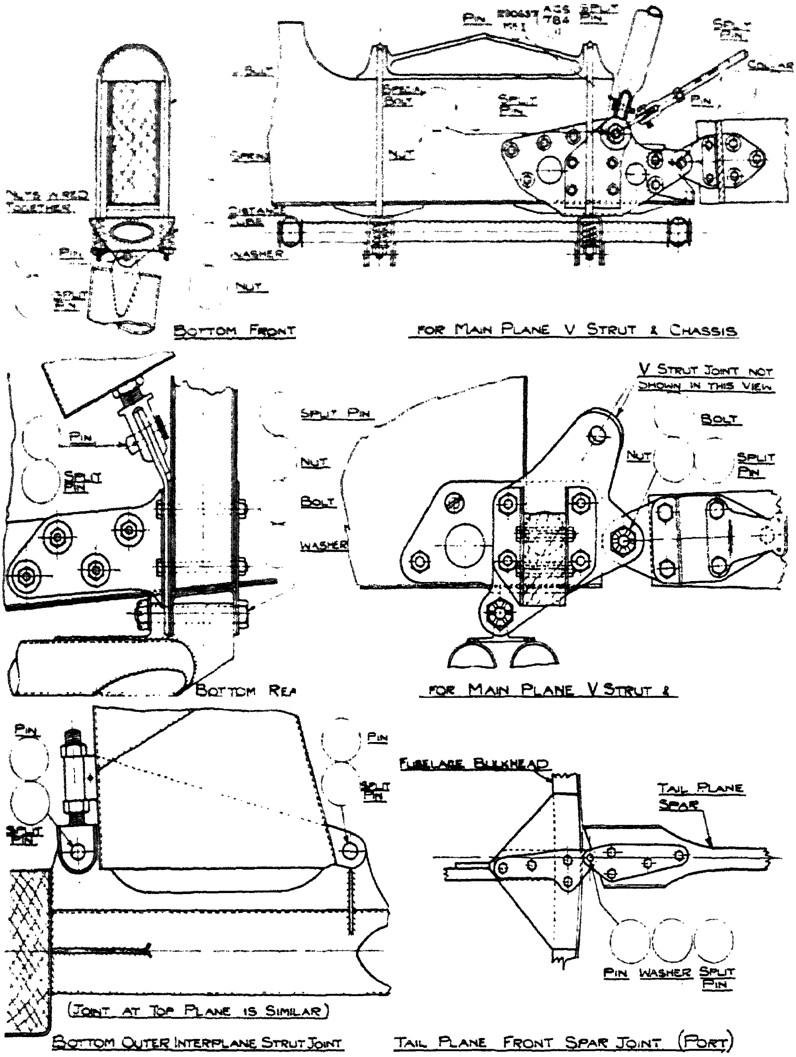


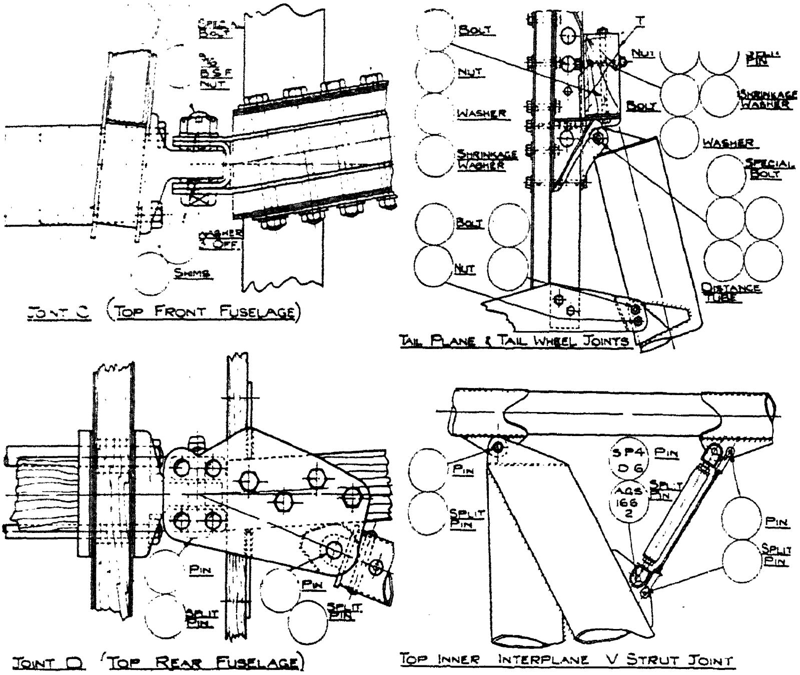
Fig. 4.—Rigging data (joints).

normal position of the spar so that packing can be used to obtain the correct rigging of the tail plane. For rigging of the tail unit see Fig. 3.

The rudder and elevator are attached to the fin and tail plane respectively and the control cables connected up. The fairings can now be fitted.

Undercarriage

The undercarriage is a rigidly braced structure, so that no adjust-



JOINT C (TOP FRONT FUSELAGE)

TAIL PLANE & TAIL WHEEL JOINTS

JOINT D (TOP REAR FUSELAGE)

TOP INNER INTERPLANE V STRUT JOINT

Fig. 4A.—RIGGING DATA (JOINTS).

ments are required. Fig. 4 shows the attachment of the compression leg and rear structure to their respective joints. To ensure that the chassis has been correctly assembled, a check measurement can be taken between the tyres; a difference of $\frac{3}{4}$ in. between the measurements taken fore and aft of the wheel centres is permissible.

Differential Aileron Control

Should the setting of the differential pulley in the top planes be disarranged for any reason, such as the dismantling and re-assembly of planes, care must be taken to re-assemble as before. This can be conveniently done by setting the differential pulley so that the angle between the radius of the control rod pivot and the centre line of the drag tube is 40° as shown in Fig. 3. With the pulley in this position the control wheel is set neutral and the aileron push rod adjusted to give a droop of approximately 0·25 in. at the trailing edge of the aileron. The full movement of control wheel should give movements as required in Fig. 3.

The aileron push-rod, once set, should not be altered except for reasons outlined below (the above remarks appertain to both sides of the aeroplane).

If the aeroplane shows a tendency to fly one wing low, first check the rigging of the wing structure and note if the differential setting is correct. Should these be found in order the trouble may be due to the slight warping of the aileron spars.

Rectification should be made in the following manner :—

(a) Disconnect both differential push-rods at the aileron end.
(b) Lengthen the push-rod on the side which tends to fly low by unscrewing the adjustable end by one turn and shortening the rod on the other side by a corresponding amount.
(c) Reconnect the push-rods.

If this adjustment proves insufficient to correct the trim of the aeroplane, the operation should be repeated until the fault is overcome. Care should be taken, however, that it is not attempted to put an incorrectly rigged aeroplane in order by this means. It should never be necessary to shorten or lengthen the adjustable push-rods by more than two, or at the most three, turns. As little as one half a turn on the nuts of the outer interplane strut adjustment will have a great effect on the trim if it is not quite correctly rigged.

Bendix Brake Adjustment (see Fig. 5).

Major Adjustment

Note. This adjustment is only necessary for initial setting of the operating cables at the works or if the undercarriage has been dismantled or when new shoes are fitted.

1. Jack up the aeroplane and remove wheels.
2. Approximately centralise shoes.
3. With the hand-brake in the "off" position, no movement of the rudder bar is transmitted to the cables A and the cables B run slack. By pulling the hand-brake "on" this slackness is taken up and the brakes commence to operate ; the rudder bar giving a differential action. If the hand-brake is pulled full "on" a differential brake action is still possible.
4. With the hand grip in the "off" position adjust the turnbuckles C on the brake-operating cables so that the operating cam in the brake is just touching the shoes without actually expanding them. The wheel should then be replaced.
5. It should now be ascertained if the brakes are free when the rudder is centralised and also that full rudder movement is obtained in both directions.
6. Any stretch which may occur in the cable D can be taken out by means of the adjustment E.

The ratchet is self-engaging and is released by turning the handle through 90°. When the handle returns to the "off" position it should be turned back through 90° in order that the ratchet is ready to engage once more.

Adjustment for Wear

This is carried out by rotating the star-wheel by means of a screwdriver inserted in the slot provided. The hand should then move inwards towards the axle to expand the brake by using the slot in the casting as a fulcrum.

Caution. The adjusting of turnbuckles must not be used to take up the linings, but only for initial setting or to compensate for any stretch in cables. Stretch should be negligible as the cables are proof loaded to half their breaking strength before fitting.

Flap Gear (see Fig. 6).

The trailing edge flaps on each stub meet beneath the fuselage and are connected by means of adjustable links to a

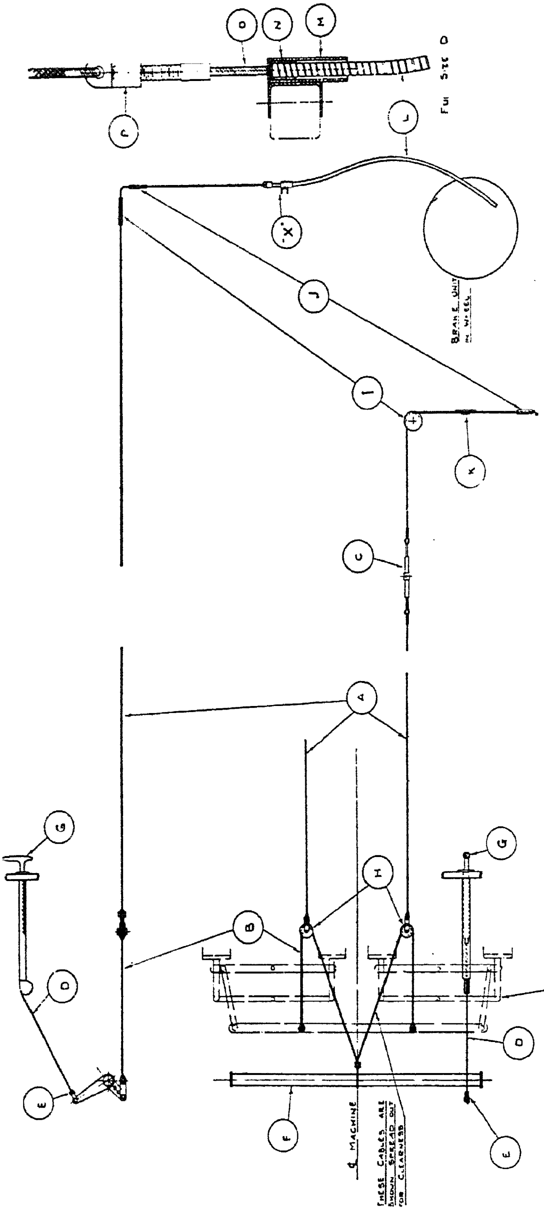
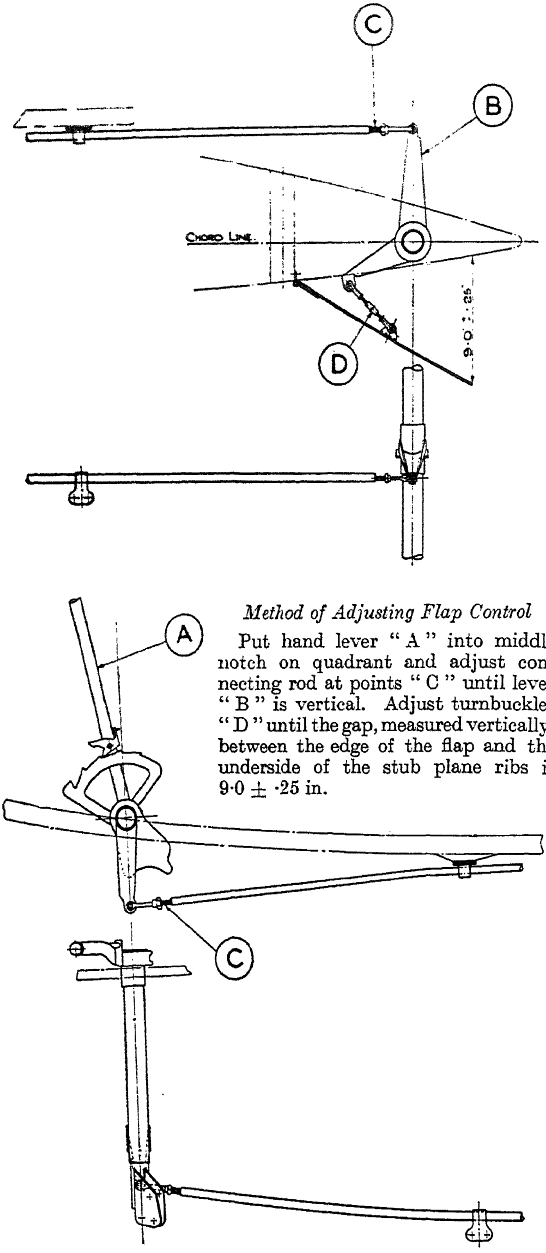


Fig. 5.—BRAKE OPERATING MECHANISM.

torque tube which moves in bearings fitted within the trailing edge of the stub planes. The torque tube is connected by means of a lever and control rod to another torque tube which is situated in the pilot's cockpit. The control lever is fitted to this torque tube and moves over a ratchet, the pawl of the ratchet being disengaged by pressing the knob at the top of the lever. The ratchet has a special catch at the forward end in order that the flap can be held in the full "up" position. The flaps are raised by depressing the knob on the top of the lever and pushing the lever forward until the catch engages. This operation is assisted by the air pressure on the flaps. The flaps can be set at various downwards positions by using the ratchet.

Should the system be dismantled for any reason care should



Method of Adjusting Flap Control

Put hand lever "A" into middle notch on quadrant and adjust connecting rod at points "C" until lever "B" is vertical. Adjust turnbuckles "D" until the gap, measured vertically, between the edge of the flap and the underside of the stub plane ribs is 9·0 ± ·25 in.

Fig. 6.—Details of flap controls.

be taken to see that the flap is adjusted by means of the control rod and flap links, until the flap rests against the trailing edge and bottom of fuselage with the control lever in the full " up " position on the catch.

Note. The flaps are intended to be operated at an air speed of 80 to 90 m.p.h.

INSPECTION

The " Dragonfly," in common with all aeroplanes, should be regularly inspected and routine maintenance carried out to ensure reliable and carefree operation. For the guidance of all concerned, the following covers broadly the points to be observed.

Before Each Day's Flying

1. Attention to pilot's previous reports, if any.
2. Inspect airscrews.
3. Inspect all covered surfaces for indications of damage.
4. Check all controls for free movement and normal operation.
5. Inspection of undercarriage, tail wheel and fuselage attachments for any signs of abnormal landing stresses.
6. Inspect wires, struts and structure generally for any signs of abnormal flying stress.
7. Inspect engines and installations to ensure no slacking, displacement, chafing or leaks, and rotate " Auto-Klean " filters.
8. Check fuel pumps independently by operating priming levers.
9. Test engines.
10. Verify that engine cowling is properly fastened.
11. Check accumulators for acid level and tightness of vents.

After a Bad Landing

1. Examine shock absorber leg units, axles and radius rods. If any signs of bowing are apparent, components affected should be replaced, as strength is impaired.
2. Examine wheels.
3. Examine attachment joints to main structure, verifying that no displacement, partial shear of pins or elongation of holes has occurred.
4. Examine bottom stub spars and fuselage members forming the structure at the attachment joints, tail wheel gear and adjacent fuselage structure. Rucking of fabric or plywood and cracking of paint are indications that opening up is advisable.
5. If the wing tip has come forcibly into contact with the ground or other object, the most likely place in which to look for damage is at or around the point of attachment of the main interplane strut and the root end attachment joint to the stub plane structure. These points can be examined by removing fairings if necessary and making small incisions in the fabric coverings, which must afterwards be sewn up and covered

with doped-on frayed-edge patches, at least 1 in. larger all round than the size of the cut.

MAINTENANCE SCHEDULE

After Every 25 Hours' Flying

1. Inspection by licensed ground engineer, including the removal of all engine cowling and inspection covers and fabric lacings to facilitate an efficient examination of airframe, controls, airscrews, instruments, electrical equipment, engines and installation.
2. Cleaning and protective measures against deterioration and corrosion.
3. Lubrication of working parts.
4. Check and adjust tyre pressures.
5. Check valve clearances and reset if necessary.
6. Dismantle, clean, re-set points and pressure-test sparking plugs.
7. Clean suction and scavenge and turn pressure oil filters.
8. Clean fuel filters and drain sumps of fuel tanks.
9. Remove and check carburetter jets and flush through float chamber, including pipe lines between filter and carburetter.
10. Check contact-breaker gaps and clean distributors.
11. Drain oil system and fill with new oil.
12. Before replacing valve gear covers, add engine oil to bring up to the level of ring on vent pipe.
13. Check tightness of airscrew bolts. This should be done more frequently if the airscrew is new or if the aeroplane is operating in a hot climate.
14. Attention to electrical equipment, such as generators, cleaning of commutators, brushes and accumulators, checking of acid and level and tightness of vents.
15. Test engines.
16. Withdraw and inspect exhaust unit of cabin heating system.

Note. Where " zipp " fasteners are provided to facilitate inspection it is advisable not to leave these in a released position for long periods, such as overnight, as the doped fabric has a tendency to contract and a big strain would be imposed on the fastener when attempting to close.

The above schedule is intended to apply when 25 hours' flying is completed in a normal period of time. If the period is unduly long, additional ground engineer's inspections are advised. The same advice applies should the aeroplane experience rough usage or abnormal conditions, or show symptoms of irregular running.

After 250 Hours' Flying

The " Auto Klean " filter should be dismantled and cleaned, including filter casing.

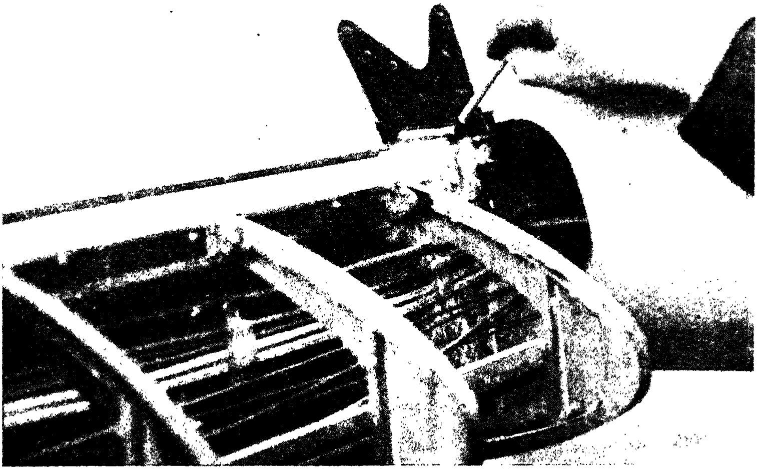
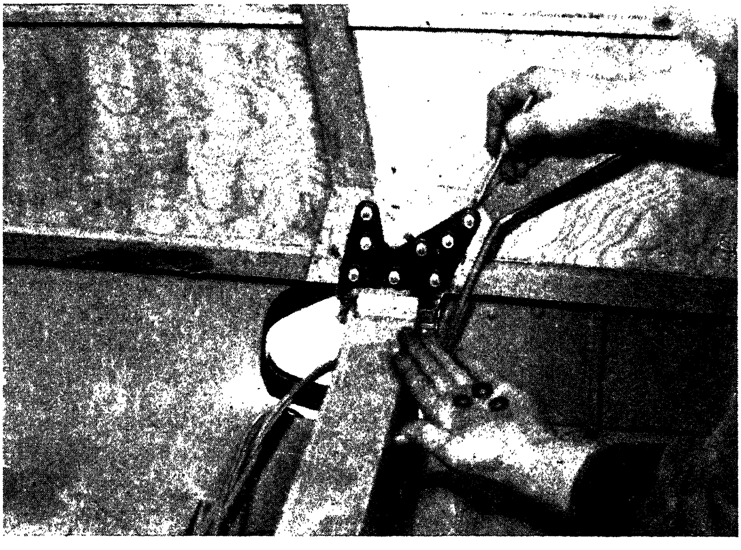


Fig. 6A.—A LIGHT ALLOY BEARING BLOCK TRANSMITS THE LOADS FROM THE WING TO FUSELAGE STRUCTURE.



6B.—THE BOLTS AT ALL MAIN JOINTS ARE PROVIDED WITH CUPPED STEEL WASHERS WHICH TAKE UP THE NATURAL SHRINKAGE OF THE TIMBER.

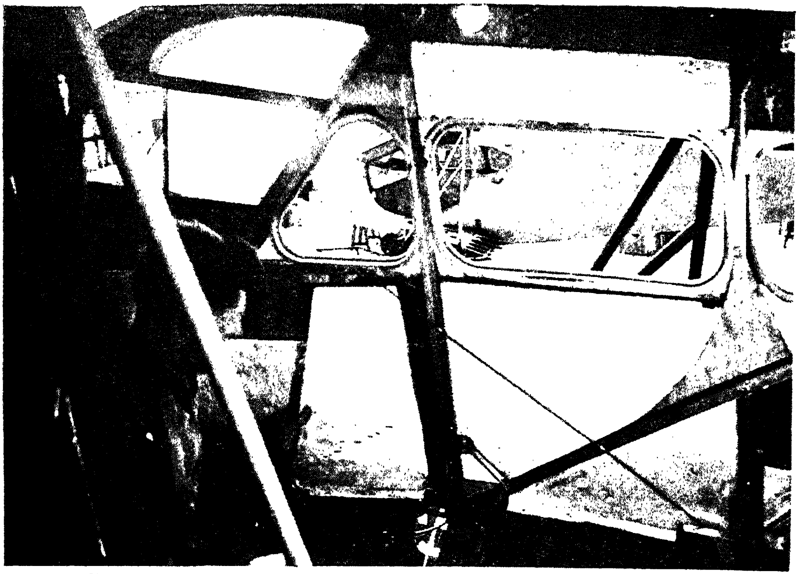


Fig. 6C.—FITTING THE "CELLECOL" SOUND PROOFING PANELS BETWEEN STRUCTURE AND UPHOLSTERY.

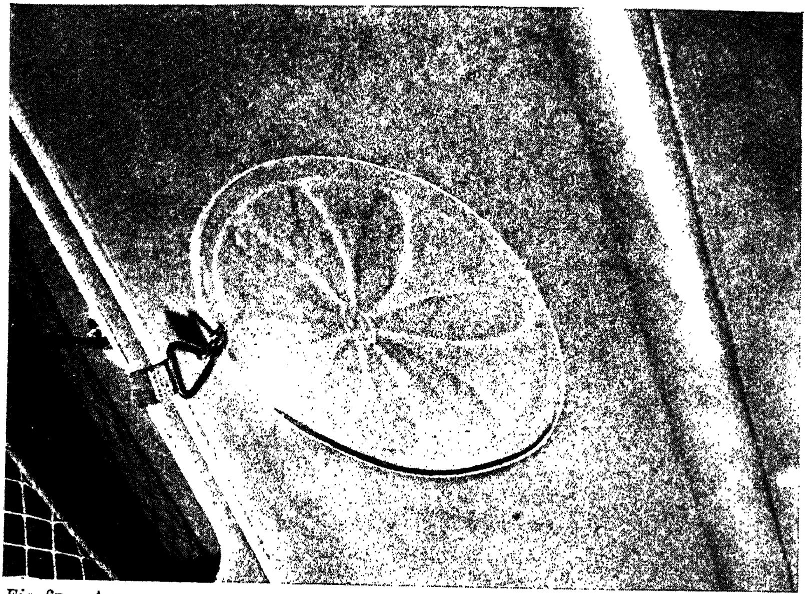


Fig. 6D.—A LIGHT CABLE IS SEWN IN THE FABRIC OF THE EMERGENCY EXIT PANEL SO THAT ON PULLING THE RING IT IS RIPPED AROUND ITS PERIPHERY TO LEAVE A CLEAR OPENING.

After 750 Hours' Flying

The engines should be taken from the airframe and given complete overhaul.

Annual Overhaul

The airframe must be overhauled annually to the requirements of the Official Inspection Authority for the renewal of the Certificate of Airworthiness.

POINTS TO BE OBSERVED DURING ROUTINE INSPECTION

Pilot's Safety Belt

The safety harness should be periodically inspected. Should there be any suspicion of deterioration in strength it should be proof-loaded.

Tyre Pressure

Tyres should not be pumped up too hard and a very appreciable flattening should be apparent on the ground. This will result in more comfortable landing and taxying and will give longer life and less wear and tear to the undercarriage and structure. The pressure should be 35 lb. per sq. in. for normal loads, *i.e.*, all up weight, about 4,000 lb.

The recommended tyre inflation pressure for the tail-wheel is 50 lb. per sq. in.

Dunlop wheels and tyres, size 4·75–7·5 in., are fitted as standard.

Engine Mounting

It is imperative that the engine should be correctly mounted in its rubber blocks, otherwise rough running and vibration may result. The caps over the rubber blocks must be fitted to give no clearance between bottoms of caps and tops of rubber blocks, but there should be no pressure on the rubber. This may necessitate the insertion of washers under the caps in order to raise them and prevent pressure on the rubber blocks.

This system of mounting allows the engine a definite amount of low-period oscillation when running slowly, *e.g.*, when ticking over on the ground or throttled back for gliding.

This movement is intentionally allowed, and is not harmful, all installation connections being arranged with sufficient flexibility to absorb it. It is important, therefore, that no rigid connections are made between engine and airframe.

When cruising, climbing, and in all normal running, this oscillation practically disappears and vibration or roughness should not make themselves felt.

If the engine feels rough at speed, although the mounting has been checked and found correct, the probable cause will be the airscrew out of balance.

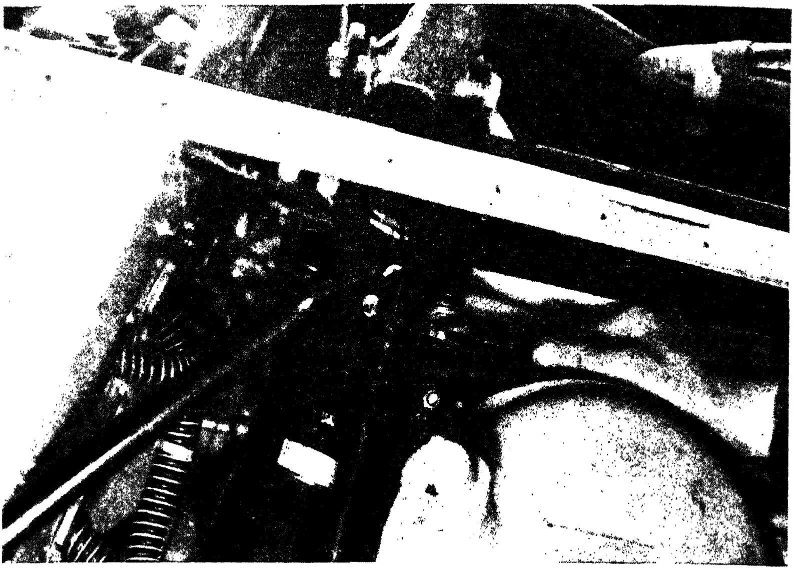


Fig. 6E.—THE LARGE SPRINGS ON "U" BOLTS HOLDING ENGINE STRUCTURE MUST BE FULLY CLOSED WHEN ASSEMBLED.

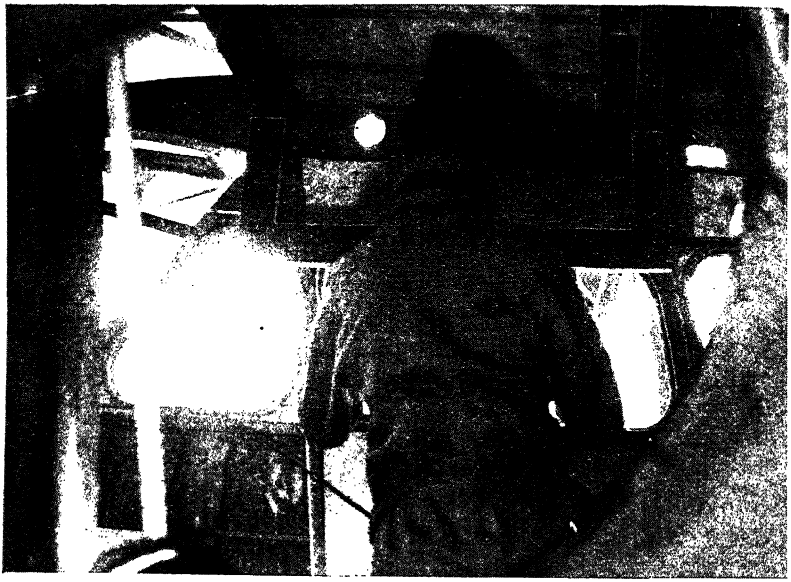


Fig. 6F.—MAKE SURE THE FRONT LEG OF THE STRAIGHTEDGE IS $1\frac{3}{16}$ IN. LONGER THAN REAR ONE WHEN LEVELLING LONGITUDINALLY FOR RIGGING.

It should be observed that when adjusting the engine for slow running this operation should be carried out with a view to obtaining smooth running as well as low revolutions.

It will be readily understood that very low revolutions are generally associated with noticeable torque reaction, which, if excessive, is injurious to any structure.

It is recommended that the slow running be so adjusted that the reaction referred to is eliminated as far as possible, at the same time keeping reasonably low revolutions.

Airscrew Out of Balance

This is the most likely cause of rough running. Make sure, however, that the engine is running evenly at normal revolutions on each magneto, tested separately.

Airscrews can only be balanced on a special balancer, correct balance being determined by relative weights of four balancing rods passed through special holes provided in the wooden boss.

Airscrews should always be fitted in the correct position for swinging to start, *i.e.*, so that compressions are pulled over by a downward movement of the hand on the blade tip, the power stroke starting before the blade tip reaches its lowest point of travel. Bolts should be tightened evenly or the airscrew will be thrown out of track, but not so tightly as to crush the wood.

Accumulators

The general necessity for installing accumulators in modern aeroplanes makes it desirable to draw attention to the vigilance which is essential to ensure the non-spilling of acid. Accumulators used are of an approved non-spillable type, but it must be understood that when under charge the acid may be under violent agitation, and acid will escape unless correct levels (as per instructions on lid) are maintained and vent and filling stoppers are kept tight and rubber washers in good condition. Cases have occurred of extensive damage to airframe structure, with grave effects on airworthiness, due to lack of attention to and appreciation of this matter.

Caution. On no account should the engine cowling be lifted for adjustments to the engine whilst the engine is running, as the front edge is liable to foul the airscrew and serious damage may result.

Deterioration of Structure

Continuous vigilance should be exercised during service to detect rust or corrosion of the metal fittings or moisture soakage of the wooden structure. Any necessary cleaning, painting and greasing should be a part of the regular routine in order to maintain the aeroplane in the best possible condition.

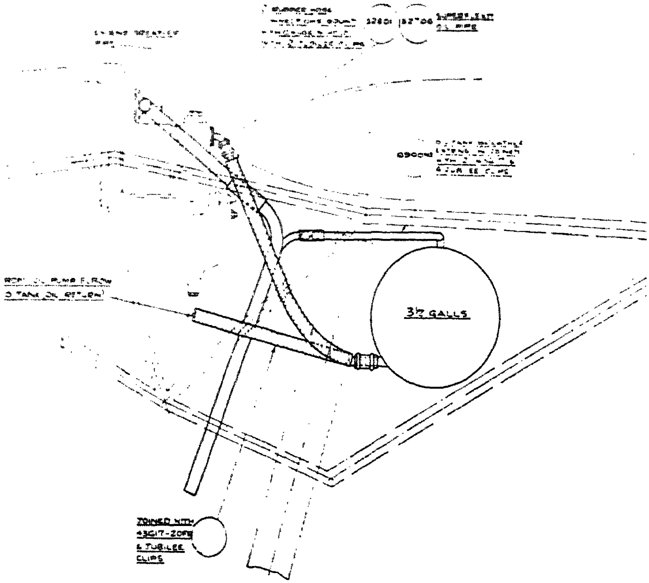


Fig. 7.—OIL SYSTEM.

A particular point should be made of keeping all drain holes in wooden structure and fabric coverings quite clear.

Should the ingress of water occur, the parts should be aired and dried out as soon as possible, after which any necessary painting or varnishing should be undertaken.

If operating in sea atmosphere, all crevices which might hold moisture, such as fork ends, pins and bedding edges of fittings, should be filled with lanoline. It is advisable to do this even for normal land operation.

Any bolts removed should be re-assembled with lanoline and fittings bedded with marine glue.

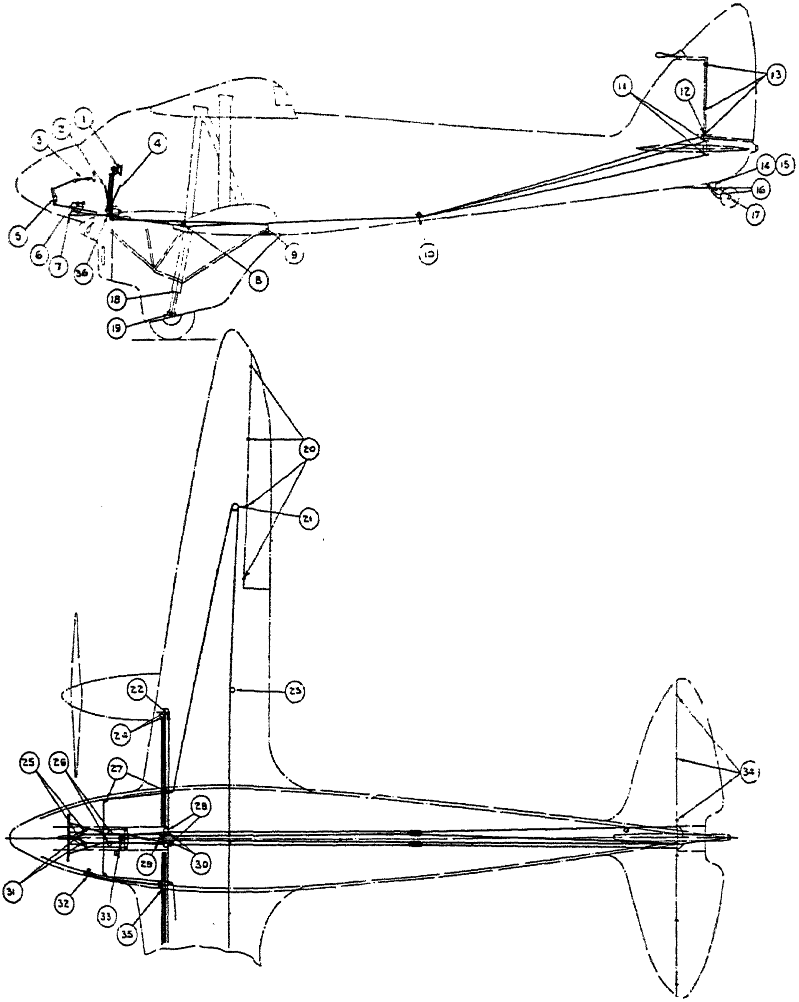
Windows

The cabin windows can be kept in good condition by careful cleaning with clear water and polishing with " Brasso " and a clean, soft cloth.

The cabin windows are " Perspex," and on no account must dope or dope solvent come in contact with the surface.

Airframe Lubrication

Generally speaking, oiling and greasing should be done after every 25 hours' flying, in accordance with the lubrication diagram, Fig. 7. Any points, however, giving signs—audible or otherwise—of needing lubrication should be dealt with immediately such signs become apparent.



○ (1) Control column head and joints.
○ (2) Flap lever ratchet and pawl.
○ (3) Brake control.
○ (4) Elevator bias lever.
○ (5) Brake torque tube and joints.
● (6) Rudder bar link pivots and bearing.
○ (7) Rudder bias gear.
● (8) Rudder control pulley.
○ (9) Flap torque tube and links.
● (10) Control pulleys.
○ (11) Elevator control wire joints.
○ (12) Rudder control wire joints.
○ (13) Rudder hinges.
● (14) Tail wheel thrust race.*
● (15) Tail wheel piston tube bearing. (2)*
● (16) Tail wheel piston pivot. (5)
● (17) Tail wheel hub bearing. (1)
● (18) Compression leg piston tube. (1)
● (19) Wheel hub bearings.*
○ (20) Aileron hinges.
● (21) Aileron differential gear.
● (22) Brake cable pulley.
● (23) Aileron control pulley.
● (24) Engine control pulleys.
● (25) Rudder bias pulleys.
● (26) Rudder control pulleys.
● (27) Aileron control pulleys.
● (28) Brake control pulleys.
○ (29) Elevator differential gear.
● (30) Rudder control pulleys.
● (31) Brake differential pulleys.
○ (32) Throttle control drum and spindle.
○ (33) Rudder bias control.
○ (34) Elevator hinges.
● (35) Engine control pulleys.
● (36) Control column pivot and joints.

Fig. 8.—LUBRICATION DIAGRAM.

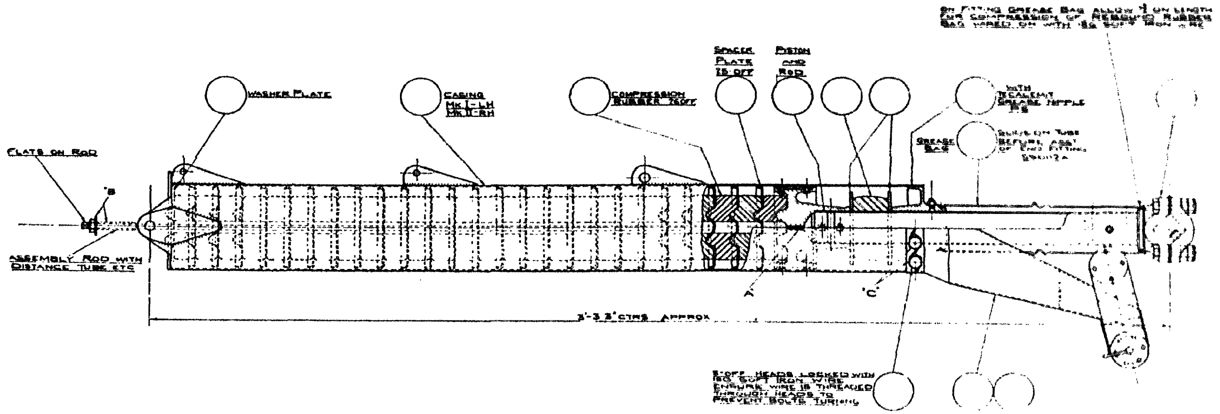

ON FITTING GREASE BAG ALLOW ¼ ON LENGTH FOR COMPRESSION OF REBOUND RUBBER BAG WIRED ON WITH 18 SOFT IRON WIRE
SPACER PLATE 15 OFF
PISTON AND ROD
WASHER PLATE
CASING MK I-LH MK II-RH
COMPRESSION RUBBER 16 OFF
WITH TECALEMIT GREASE NIPPLE
GREASE BAG
SLIP ON TUBE BEFORE ASSY OF END FITTING
FLATS ON ROD
B
ASSEMBLY ROD WITH DISTANCE TUBE ETC
A
C
3'-3 3/4" CTRS APPROX
2 OFF HEADS LOCKED WITH 18G SOFT IRON WIRE ENSURE WIRE IS THREADED THROUGH HEADS TO PREVENT BOLTS TURNING

Fig. 9.—DETAILS OF COMPRESSION LEG.

Method of Assembly.

Assembly rod screwed into piston assembly at " A " and rubbers and spacer plates threaded on.

Casing slipped on so that the rod extends through at the top.

The initial compression is applied to the column of rubbers by means of a distance tube washer and nut as shown at " B " until screws " C " at the bottom of casing can be put in.

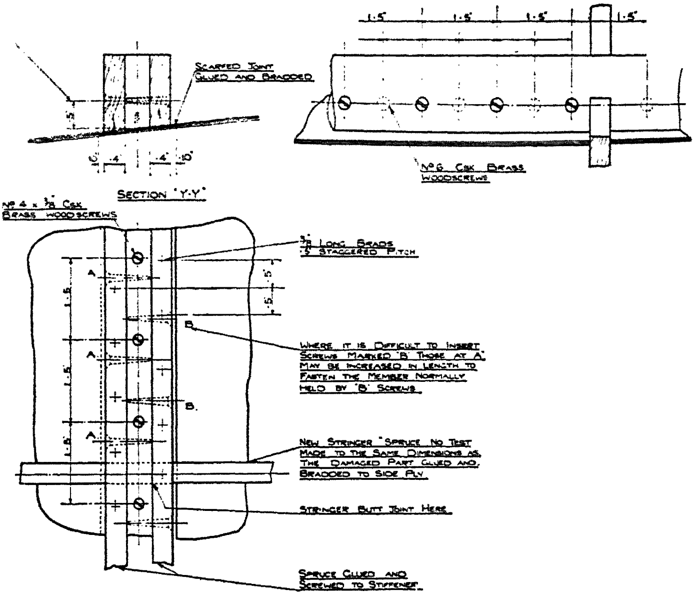
The screws are then locked, and the assembly rod is removed.

Assembly Rod.

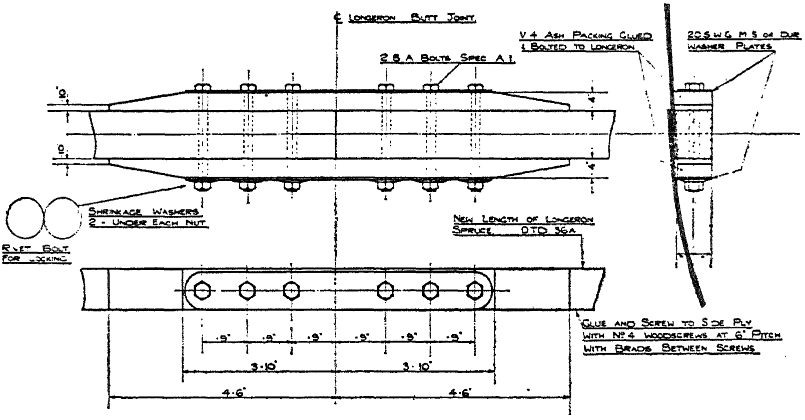
$\frac{3}{16}$ in. dia., 2 ft. 4 in. long screwed 2B.A. $\frac{3}{4}$ in. at bottom, $4\frac{1}{4}$ in. at top. *Flats at top for turning purposes.*

Distance Tube.

$\frac{5}{16}$ in. O/D × 17G. × 1·5 in. long.


1·5"
1·5"
1·5"
1·5"
SCARFED JOINT GLUED AND BRADDED
·5"
·10"
·4"
·4"
·10"
Nº 6 CSK BRASS WOODSCREWS
SECTION 'Y-Y'
Nº 4 × 3/8 CSK BRASS WOODSCREWS
3/8" LONG BRADS ·5" STAGGERED PITCH
·5"
·5"
1·5"
1·5"
1·5"
A
A
A
B
B.
WHERE IT IS DIFFICULT TO INSERT SCREWS MARKED 'B' THOSE AT 'A' MAY BE INCREASED IN LENGTH TO FASTEN THE MEMBER NORMALLY HELD BY 'B' SCREWS
NEW STRINGER 'SPRUCE NO TEST' MADE TO THE SAME DIMENSIONS AS THE DAMAGED PART GLUED AND BRADDED TO SIDE PLY
STRINGER BUTT JOINT HERE
SPRUCE GLUED AND SCREWED TO STIFFENER

REPLACEMENT OF DAMAGED PLY PANELS.


℄ LONGERON BUTT JOINT
V 4 ASH PACKING GLUED & BOLTED TO LONGERON
20 S.W.G. M.S. OR DUR WASHER PLATES
2 B A BOLTS SPEC A.1.
·10
·10
·4"
·4"
SHRINKAGE WASHERS 2 - UNDER EACH NUT
RIVET BOLT FOR LOCKING
NEW LENGTH OF LONGERON SPRUCE DTD 36A
GLUE AND SCREW TO SIDE PLY WITH Nº 4 WOODSCREWS AT 6" PITCH WITH BRADS BETWEEN SCREWS
·9"
·9"
·9"
·9"
·9"
·9"
3·10"
3·10"
4·6"
4·6"

STANDARD Lc

.:- THE EXTERNAL FACES OF ALL RS ARE TO BE NAL SURFACES

g. 10.—:

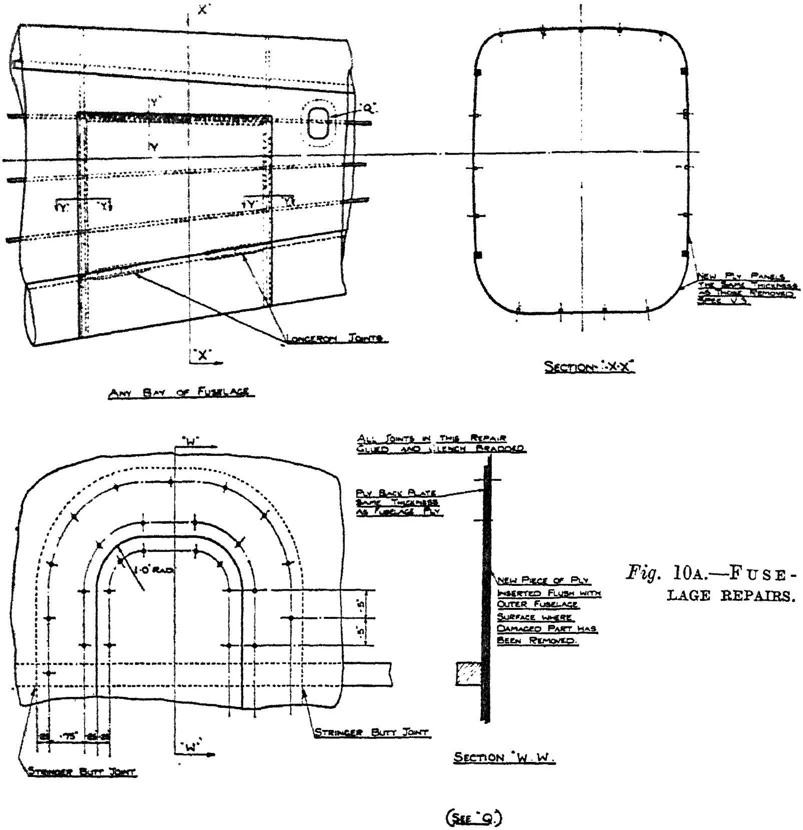

"X"
"Y"
"Y"
"Q"
"Y" "Y"
"Y" "Y"
Longeron Joints
"X"
Any Bay of Fuselage
New Ply Panels The Same Thickness as those Removed (See "V")
Section "X-X"
"W"
All Joints in this Repair Glued and Clench Bradded
Ply Back Plate Same Thickness as Fuselage Ply
1·0" RAD.
New Piece of Ply Inserted Flush with Outer Fuselage Surface where Damaged Part has Been Removed.
·5"
·5"
·75"
Stringer Butt Joint
"W"
Stringer Butt Joint
Section "W-W"
(See "9")

Fig. 10A.—FUSELAGE REPAIRS.

Exhaust Unit—Cabin Heating System

It is essential that the exhaust units of the cabin heating system should be regularly routine inspected and this item of work is included under the recommended 25-hour maintenance schedule.

This inspection is easily carried out by releasing the clamping ring at the forward end of the muff and withdrawing the exhaust pipe.

It must be appreciated that any crack in the exhaust pipe within the muff may result in exhaust fumes entering the cabin through the heating system.

Fuel System

It is of the utmost importance that pilots and engineers should be conversant with the system of fuel supply controls, as otherwise failure of one or both engines may result for no apparent reason.

If air gets into the fuel pipes, a complete stoppage of supply to the engines may result, although there is plenty of fuel on board. This applies to all types of aeroplanes.

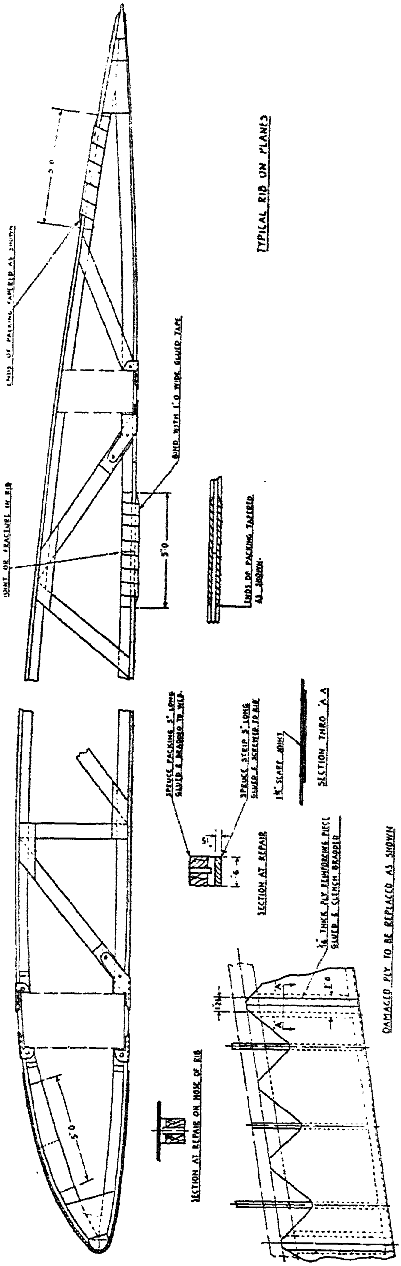
For example, on the D.H.90, if both engines are being fed from both tanks connected together as would be the case with controls set at "3–3" and the port tank runs dry before the other, air can enter the system through the port tank fuel pipe and prevent fuel from the starboard tank from reaching the port engine. Further, this air may in some cases even travel along the pipe connecting the two tanks and prevent fuel in the starboard tank from reaching the starboard engine, thus causing complete stoppage of both engines.

If the instruction diagram fitted in the aeroplane is adhered to and the fuel system is maintained in proper condition, the failures mentioned above will be avoided.

When operating cables are adjusted for tension, care must be taken that with the levers in No. 1 position the white lines on pulleys should coincide exactly with those on spar and those on cable guards.

Undercarriage Compression Leg

The compression leg is extremely simple, the only moving part being the bottom telescopic tube and its piston.


TYPICAL RIB ON PLANES
ENDS OF PACKING TAPERED AS SHOWN
5'0
BIND WITH 1'0 WIDE GLUED TAPE
JOINT OR FRACTURE IN RIB
5'0
ENDS OF PACKING TAPERED AS SHOWN.
SPRUCE PACKING 5" LONG GLUED & BRADDED TO WEB.
SPRUCE STRIP 5" LONG GLUED & SCREWED TO RIB
5"
·6"
SECTION AT REPAIR
1¼" SCARF JOINT
SECTION THRO 'A A'
1/16 THICK PLY REINFORCING PIECE GLUED & CLENCH BRADDED
1'0
A
A
1¼"
DAMAGED PLY TO BE REPLACED AS SHOWN
5'0
SECTION AT REPAIR ON NOSE OF RIB

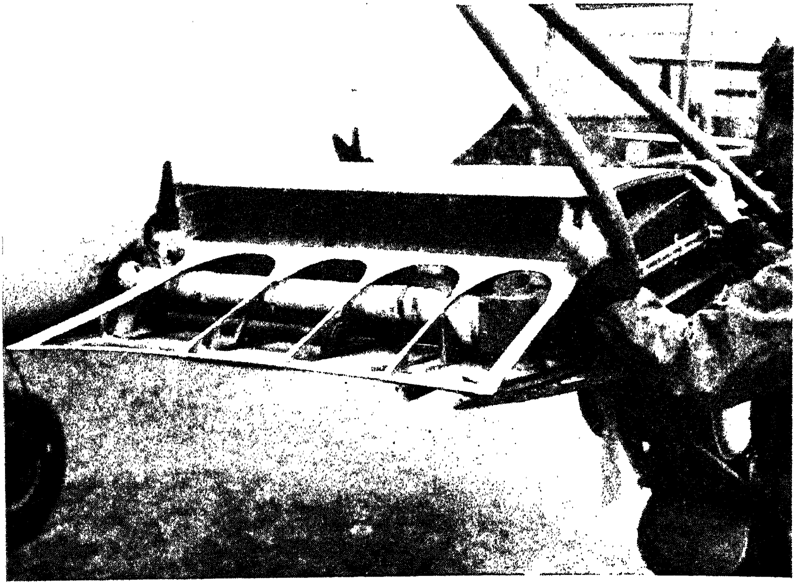


Fig. 11A.—THE PANELS FORMING COVER OVER PETROL TANKS ARE PART OF THE STRUCTURE, AND EVERY BOLT MUST BE SECURELY FITTED.

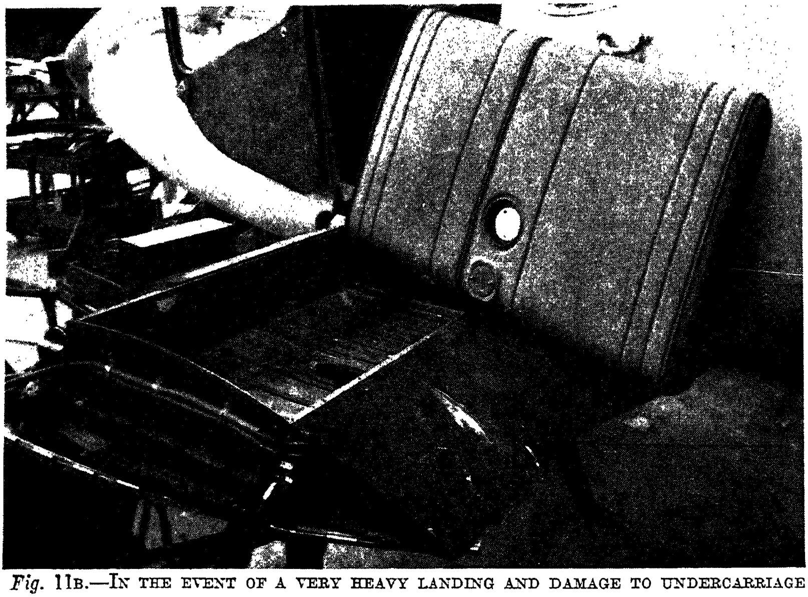


Fig. 11B.—IN THE EVENT OF A VERY HEAVY LANDING AND DAMAGE TO UNDERCARRIAGE THE PETROL TANK SHOULD BE REMOVED TO ALLOW EXAMINATION OF SPARS JUST ABOVE.

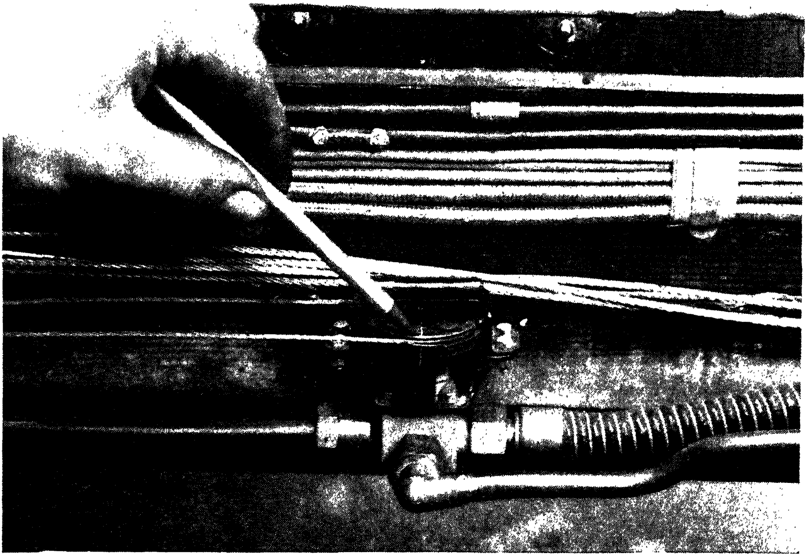


Fig. 11C.—THE PETROL COCK CONTROL PULLEY WITH LEVER IN NO. 1 POSITION. The white lines on pulleys must coincide exactly with those on pulley cable guard.

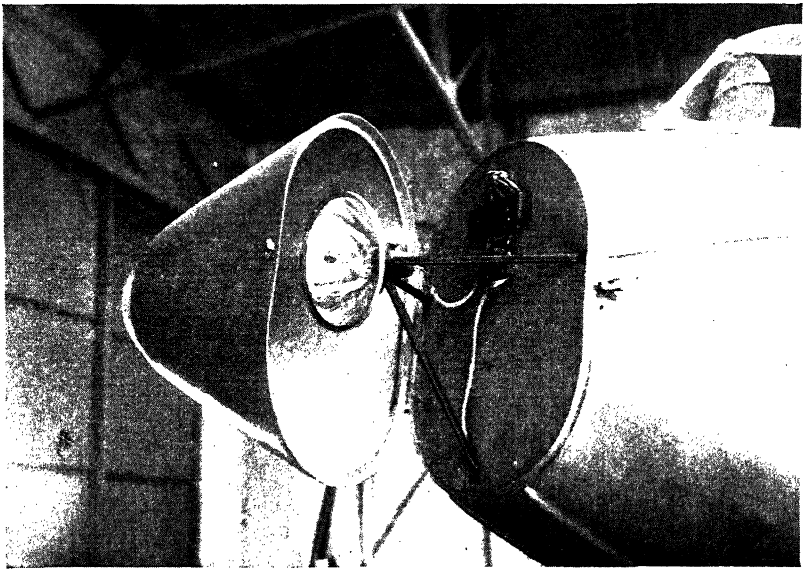


Fig. 11D.—THE LANDING LIGHT IS ACCESSIBLE BY HINGING THE METAL NOSE.

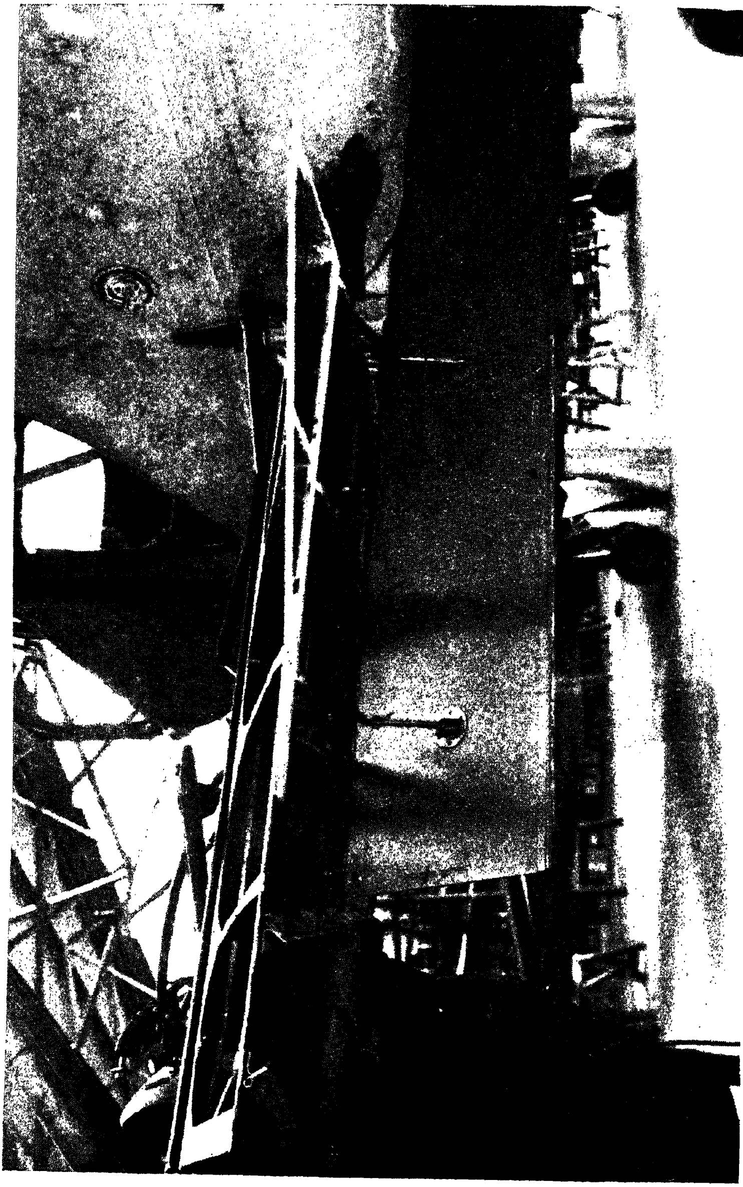


Fig. 11E.—The Link Gear for operating Flap shown in approximately two-thirds down position.

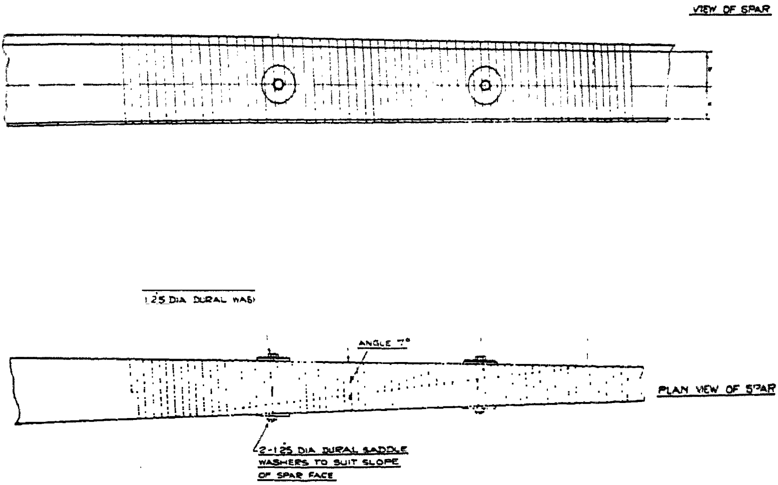


Fig. 12.—REPAIR TO WING SPAR TIP.

Maintenance

A charge of grease through the nipple located immediately below the outer casing should be given during the 25-hour maintenance routine.

Dismantling and Replacements

The legs should be dismantled periodically or when there is any doubt regarding their functioning.

To dismantle the leg a $\frac{3}{16}$ in. diam. rod 2 ft. 4 in. long, screwed 2 B.A. × $\frac{3}{4}$ in. at bottom and $4\frac{1}{4}$ in. at the top, is required with flats at the top for turning purposes. These are shown on Fig. 9.

This rod is inserted through the hole in the top of the leg and screwed into the piston and, by adding the distance tube with a washer and nut, the telescopic tube can be drawn up and the rubbers compressed by tightening the nut. This allows the rubber recoil block to expand and the load is taken off the retaining bolts of the lower sleeve. These bolts can now be removed and on releasing the assembly rod the telescopic tube, rubbers, spacers, etc., can be removed from the lower end. The assembly is accomplished by reversing the process. Care must be taken to ensure that the rubbers and spacers are inserted alternately and that the correct number of each is replaced. This can be ensured by threading them on the assembly rod before sliding on the outer casing.

Points of Special Attention

(*a*) Wear on sliding tube and sleeve.
(*b*) Wear on friction piston. (This can be noticed by springy taxying.)
(*c*) Deterioration of rubbers. (This can be noticed by heavy taxying.)

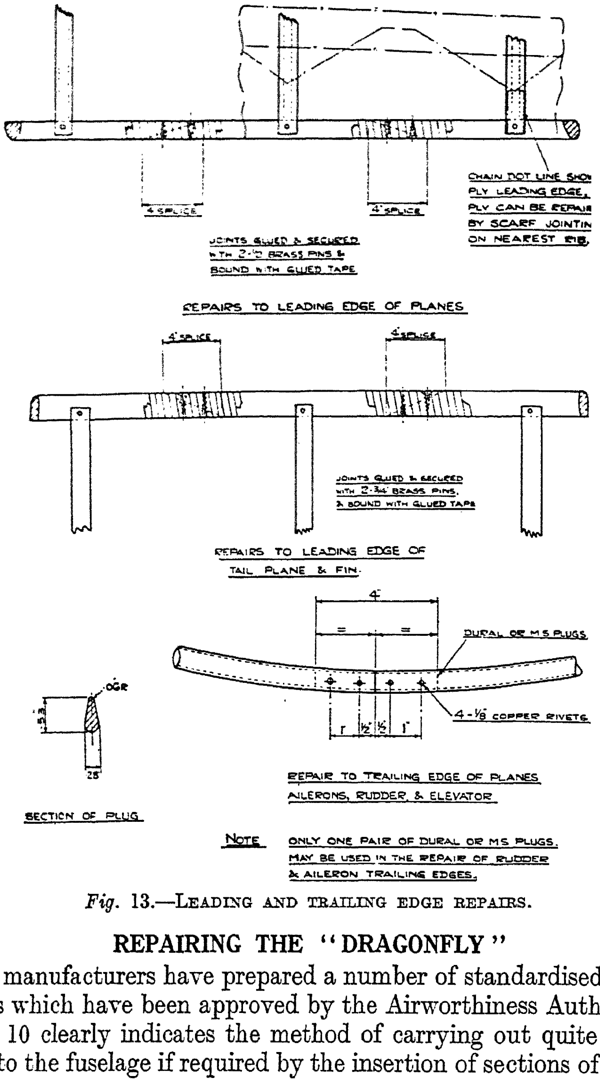


Fig. 13.—Leading and trailing edge repairs.

REPAIRING THE "DRAGONFLY"

The manufacturers have prepared a number of standardised repairing schemes which have been approved by the Airworthiness Authorities.

Fig. 10 clearly indicates the method of carrying out quite extensive repairs to the fuselage if required by the insertion of sections of longerons and repairs and replacements of ply structure.

Fig. 11. Repairs to main plane ribs.
Fig. 12. ,, spar tips and ply nose.
Fig. 13. ,, leading and trailing edges.

Structural components which are damaged and not covered by the above schemes must be replaced by new parts obtained with the official release note from the manufacturers or special repair schemes prepared and submitted for approval.

THE DE HAVILLAND "FOUR-ENGINED EXPRESS AIR LINER"

(TYPE D.H. 86, 86 A and 86 B)

By A. J. Brant, *Service Manager, de Havilland Aircraft Ltd.*

THE de Havilland Aircraft Type 86, 86 A and 86 B, known as the "Four-Engined Express Air Liner," is, we believe, being used in greater numbers on air line work than any other of its class. The details and particulars of construction, operation, rigging and maintenance to be given will be of great value to the large number of persons who will inevitably be connected with the operation of this type for several years.

Introductory Remarks

The maximum permissible all-up weight of these aeroplanes varies from 10,000 lbs. for the original type 86 to 11,000 lbs. for the type 86 A or 86 B when fitted with Gipsy Six Series II. engines and controllable pitch airscrews. The example of performance data is taken for a type 86 B with Gipsy Six Series I. engines and fixed pitched airscrews with a maximum permissible weight of 10,250 lbs. The permissible all-up weight of any individual aeroplane can, of course, always be ascertained by reference to its Certificate of Airworthiness.

Power Plant of D.H. 86

The power plant of the type 86 is limited to Gipsy Six Series I. engines with fixed pitch airscrews. The 86 A development was influenced principally by the coming availability of the higher power Series II. Gipsy Six engine and the advent of the de Havilland controllable-pitch airscrew. The use of the Standard Gipsy Six Series I. engine with fixed-pitch airscrews, however, is also continued for the convenience of operators of short routes where first cost of equipment is of greater importance than the highest possible performances.

The airframes of each type are almost the same, but structural improvements introduced on the 86 A and 86 B permit the increase of the all-up weight.

The improvements introduced into the type 86 A are briefly as follows :—

(*a*) Strengthening of the main structure, allowing a higher maximum permissible weight.

(*b*) Entirely new undercarriage design incorporating well-tried principles of pneumatic compression legs, reinforced tyres, and larger and more powerful brakes.

(*c*) Improved tail-wheel unit incorporating the "Dunlop Ecta" type tyre.

(*d*) Engine cowling redesigned to minimise drag and to give greater accessibility to the power installation to facilitate maintenance.

(*e*) Dual control fitted as standard and general improved comfort for crew. Improved commander and first officer seats, cockpit windows and instrument lighting.

(*f*) The wing-tip profile altered to give a higher degree of lateral stability at low speeds and increased lift under take-off conditions.

(*g*) Improved cabin sound-proofing, heating and ventilation.

(*h*) The use of a rudder servo-flap in conjunction with adjustable fin which entirely counteracts the effect of uneven thrust occasioned by one or two engines out of action and enables the aeroplane to be flown with full load in this condition, without undue strain on the pilot. The servo-flap is operated by the fin trim gear and not by the rudder (see special notes under "Rigging Tail Unit").

The essential differences between the 86 A and 86 B are as follows :—

(*a*) The introduction of fixed fins to the extremities of the tail plane, involving alterations to the tail plane and elevators.

(*b*) The addition of a trim bias gear in the elevator control system.

(*c*) The provision of a guard between the rudder bars in the pilot's cockpit.

GENERAL DESCRIPTION

The Four-engined Express Air Liner is a two-bay bi-plane comprising top stub, top extension, bottom stub, bottom intermediate and bottom extension planes.

The four engines are mounted in structures forward of the lower planes and fitted with tractor airscrews.

The undercarriage structure is faired in with the inboard engine mountings. The aeroplane has a wing span of 64 ft. 6 in., overall length of 46 ft. 1¼ in., and approximate height (tail down over fixed aerial) 13 ft.

The cabin is 16 ft. long by 4 ft. 10 in. wide and 5 ft. 10 in. high and can be equipped and furnished to the individual requirements of the operator.

A lavatory is provided and a rear luggage compartment of 76·5 cu. ft. capacity. A further luggage compartment of 19 cu. ft. is in the front fuselage and is accessible by hinging the metal nose-piece.

Performance

Note.—All performance figures quoted are based on the most accurate possible tests carried out in England and reduced to international standard atmospheric conditions. It must be borne in mind that the local conditions of temperature, humidity and barometric pressure have an important influence on performance.

	D.H. 86 B.
Total all-up weight	10,250 lbs.
	Gipsy Six Series I. Engines.
Maximum speed at sea level	162–166 m.p.h.
Cruising speed at 1,000 ft.	138–142 m.p.h.
Fuel consumption cruising as specified above	35·5 galls./hr.
Ultimate range—	
With 114 gallons	450 miles.
With 191 gallons	750 miles.
Take-off in 5 m.p.h. wind	340 ± 30 yards.
Height at 656 yards from rest in 5 m.p.h. wind	100 ± 20 ft.
Landing run with wheel brakes and flaps in 5 m.p.h. wind	175 ± 30 yards.
Gliding angle—	
With flaps up	1 in 11.
With flaps down	1 in 8½.
Rate of climb at sea level	925 ft./min.
Time to climb 5,000 ft.	6·5 minutes.
Time to climb 10,000 ft.	15 minutes.
Absolute ceiling	19,500 ft.
Service ceiling	17,400 ft.
Ceiling with one engine stopped	13,000 ft.
Ceiling with two engines stopped, according to combination	2,000–4,000 ft.

CONSTRUCTION

The top stub and extension and bottom intermediate and extension planes consist of substantial I-section spruce spars reinforced with packings where necessary, with spruce leading and trailing edges.

The leading edge and tips of the planes are ply-covered and ply stiffening is arranged in the region of the interplane strut joints.

The internal drag struts are of steel tube, the lugs for swaged rods and high tensile steel wire bracing being integral with the tube, making a structure which is not affected by any slight shrinkage which might take place in the wooden spars.

The inner intermediate interplane struts are of tubular steel, while a single outer interplane strut, made of metal, is attached to the front and rear spars.

The bottom stub plane has tubular metal spars passing under the

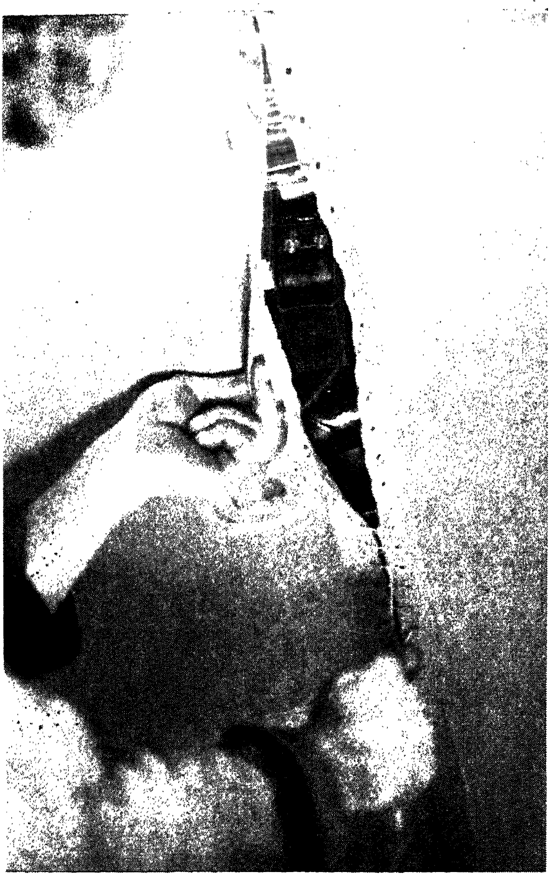


Fig. 1.—JACKING PAD.

Showing fabric unlaced underneath the root end of the main planes to disclose jacking pads on main members.

fuselage and bolted to fittings on the bottom longeron and to the fuselage cross members on the underside of the cabin floor.

The structure of the planes is streamline wire braced except for the portion between the inner engine mountings and the fuselage, at which point tubular streamline struts are fitted.

These struts also take the undercarriage loads on landing.

Incidence wires are not used at the inner interplane struts. A tubular diagonal steel strut is fitted, running from the bottom front to the top rear spars.

Tail Unit

The tail plane consists of spruce spars covered with three-ply and stiffened with spruce ribs and formers. The tail plane is hinged at the rear spar and supported at the apex of the front spar by a tube adjustable in length by means of a screw capable of being rotated by cables operated by a hand-wheel in the cockpit. The tail plane is rigidly braced by streamline wires to the top of the fin post and to the bottom of the fuselage.

The elevators comprise spruce spars and braced diagonal ribs, so arranged to take torsional loads ; the left and right elevators are coupled together at the centre by a steel fitting which incorporates the control lever.

The fin consists of a spruce spar and ribs covered with three-ply.

Fig. 2.—SHOWING HOW JACKING PADS FORM THE MAIN TRESTLING POINTS.

The three-ply is covered with doped fabric, and as both the tail plane and fin depend on the three-ply skin for their torsional stiffness, it is important that the aeroplane should not be flown with this ply seriously damaged.

The rudder consists of a welded structure of steel tube. The joints between ribs, spars and trailing edge are made with steel gussets welded on; the whole being covered with fabric. The fin is capable of a sideways adjustment which, in conjunction with the rudder servo-flap, entirely counteracts the effect of uneven thrust occasioned by one or two engines being out of action. This adjustment is controlled by cables operated by a hand-wheel in the cockpit. The servo-flap is operated by the fin trim gear and not by the rudder.

The tail unit is rigidly attached and the rear fuselage specially strengthened to deal with the torsional loads which may be set up.

The longitudinal trim is controlled by a large diameter hand-wheel which, by means of cables, rotates the screw gear, attached to the tail plane front spar. The operating load in the cables has been kept small so as to avoid stretch and consequent backlash in the mechanism.

Fuselage

The fuselage is constructed of spruce longerons and members covered with three-ply. An outer covering of fabric supported by suitable stringers is fitted. Joint plates are of steel and all fittings taking wing loads are steel forgings.

The bolts at all joints are provided with cupped steel washers which allow for the natural shrinkage of the timber to take place without the consequent loosening of the bolts.

The cabin is sound-proofed with "Cellacol" insulation, fitted between the three-ply sides and the outside fabric.

The cabin windows are transparent flexible sheet, which are unbreakable and can be kept in perfect condition if periodically washed with clean water and polished with metal polish, using a soft, clean cloth.

The cabin is provided with one door fitted with a safety bar which slides across the door opening. Two emergency exits are provided in the roof of the cabin, also adjustable heating and ventilating devices are fitted as standard.

Various arrangements of passenger accommodation are supplied, consisting of cabin, lavatory, and luggage compartment, and cabin only occupying the whole space available. An outside independent door is fitted to the luggage compartment.

Except on a few of the earliest "86" types, dual control is fitted as standard. Wheel control of the ailerons is provided, while the elevator control is by fore and aft movement of the control column.

The rudder bars are duplicated, while the control column is of the throw-over type.

The tail trim and fin bias control wheels are arranged conveniently for either pilot, also one of the pilot's seats is rotatable to facilitate operation of the radio set.

The front windows of the cockpit are of unsplinterable glass; opening side windows of similar material are also fitted.

A single-bladed windscreen wiper is provided for the principal pilot.

The engine controls are fitted to the instrument board convenient to both pilots.

Additional space is provided in the extreme nose of the fuselage for small luggage or mail.

All control cables are carried under the cabin floor and are protected from the weather by a fabric covering with large fabric panels secured with "zipp" or hook lace fasteners to allow of inspection with the minimum of trouble.

The rear fuselage is provided with holes in the bottom to enable a thorough inspection to be made of the interior.

Engine and Tanks

Electric engine starters (Type Rotax "Eclipse" Y.150) are fitted, operated from the normal starter battery by buttons situated on the instrument board or on the top of the control box. In both cases the buttons are protected by safety covers to obviate the chance of accidentally starting the engines.

The mountings for the engines and the main fuel and oil tanks consist of all-metal tubular structures built into the bottom stub plane for the inboard engines and bolted on to the bottom intermediate plane for the outboard engines. Metal and asbestos fireproof bulkheads are fitted between the engines and the tanks.

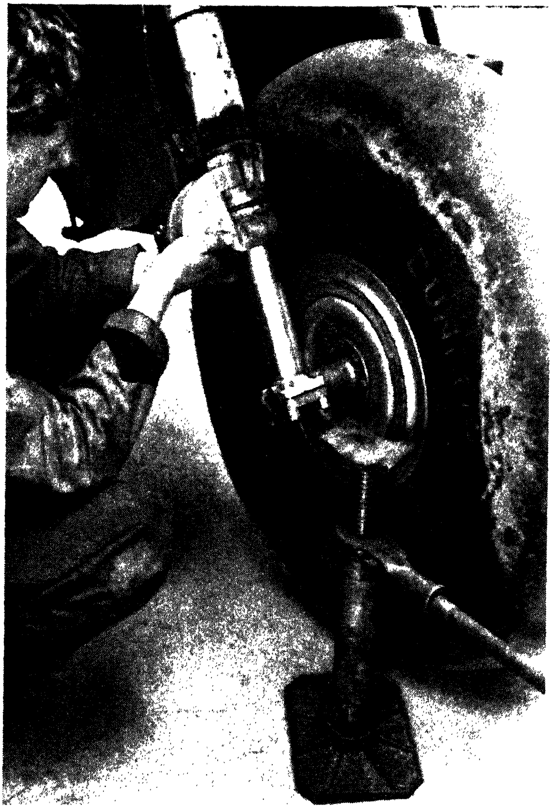


Fig. 3.—JACKING PADS TO CLAMP ON UNDERCARRIAGE LEGS CAN BE FITTED TEMPORARILY TO DEAL WITH WHEEL CHANGING.

Fuel System

A welded aluminium fuel tank of 57 gallons capacity is fitted behind each inboard engine, and isolated by means of an aluminium and asbestos fireproof bulkhead. Two welded aluminium auxiliary fuel tanks, each of 38½ gallons capacity, situated in the bottom stub planes and slung between the spars in langite covered metal straps are held down by cables covered with rubber tubing. These auxiliary tanks are coupled to the sumps of the main tanks and empty in conjunction with same. The filler caps of these auxiliary tanks must be screwed down tightly as they are under a small pressure from the main tanks when they are full.

Fuel is supplied by twin engine driven diaphragm pumps on each engine. It is necessary to flood the carburetter. This is done by actuating a lever on the body of the pumps. Individual functioning of pumps should be checked by flooding carburetters with each in turn.

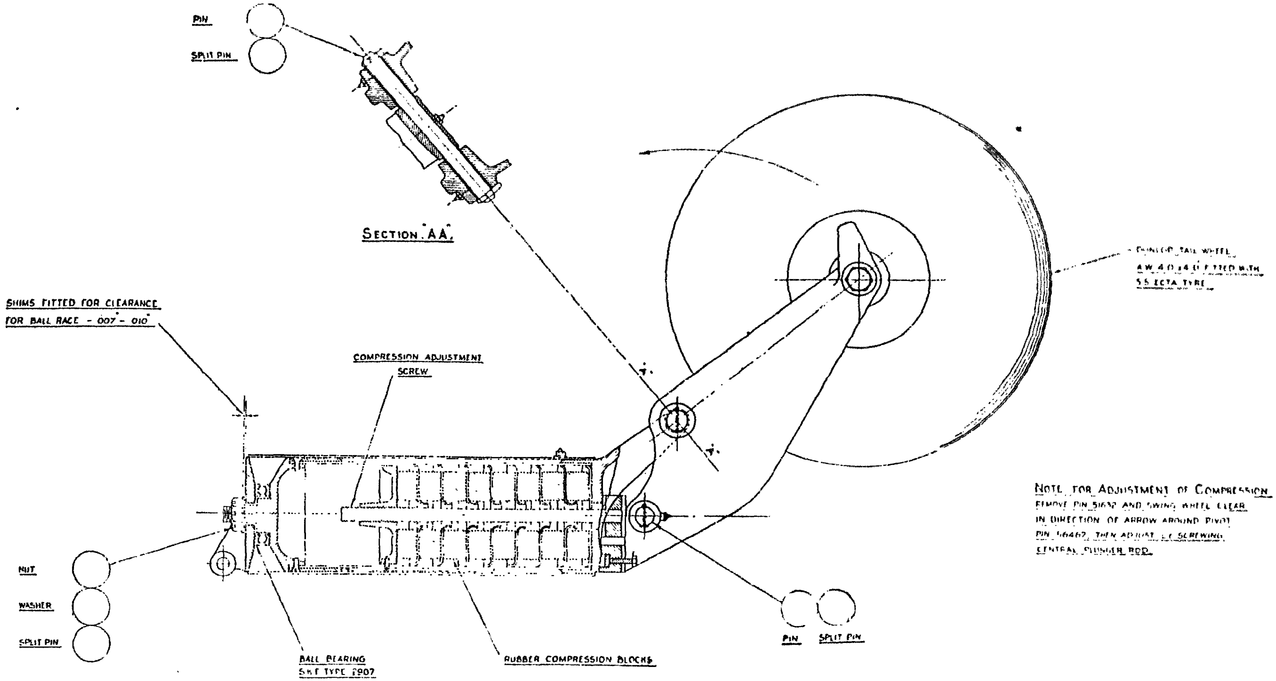

PIN
SPLIT PIN
SECTION "AA"
SHIMS FITTED FOR CLEARANCE
FOR BALL RACE - ·007"- ·010"
COMPRESSION ADJUSTMENT SCREW
NUT
WASHER
SPLIT PIN
BALL BEARING S.K.F. TYPE 2907
RUBBER COMPRESSION BLOCKS
PIN
SPLIT PIN
"A"
"A"
DUNLOP TAIL WHEEL
A.W. 4.0 x 4.0 FITTED WITH
5.5 ECTA TYRE
NOTE FOR ADJUSTMENT OF COMPRESSION
REMOVE PIN 51632 AND SWING WHEEL CLEAR
IN DIRECTION OF ARROW AROUND PIVOT
PIN 56467, THEN ADJUST I.E. SCREWING
CENTRAL PLUNGER ROD.

Fig. 4.—DETAILS OF TAIL WHEEL.

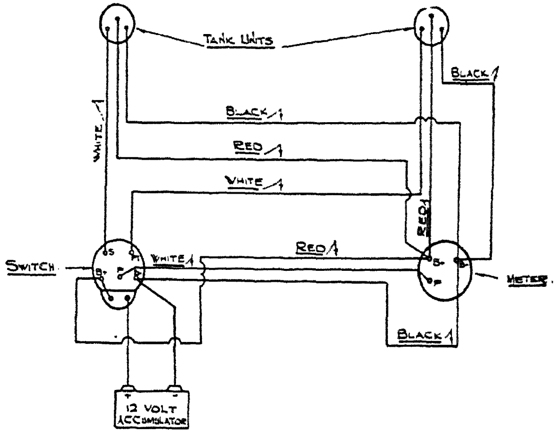


Fig. 5.—WIRING FOR ELECTRIC FUEL GAUGE.

Oil supplied from an oil tank fitted behind each of the four engines by means of the engine pump passes through a filter on the engine before entering. These oil tanks are each of 3½ gallons effective capacity and have a half-gallon air space above the maximum oil level. They are fitted with dip sticks in which the bottom marking is arranged to leave 12 pints of oil in reserve. The engines should not be allowed to run with the oil level below this bottom marking on the dip stick.

The main fuel tanks and oil tanks are slung in cables covered with rubber to damp out vibration.

Undercarriage

The undercarriage consists of one wheel under each inboard engine mounting attached to a rigidly braced structure, the only external moving parts being the piston tubes and fittings which slide in the outer casings of the shock absorber legs. There are no hinged parts to move, consequently the points at which wear might occur have been reduced to a minimum. The wheel axles are supported at each end in trunnions with detachable caps, the axle ends being square to take the brake torque. The wheels are encased in streamline fairings designed to improve the performance and appearance of the aeroplane in addition to keeping it clean by acting as a mud shield.

The type 86 is fitted with the " Dowty Patent Spring Leg " and the 86 A and 86 B with the " Turner Compressed Air Landing Legs."

The " Dowty leg " uses a system of steel coil compression springs designed to give the desired shock-absorbing characteristic, with an arrangement of expanding split cones and a spring loaded friction clamp for rebound damping.

The " Turner " landing legs operate with compressed air only except for a small amount of oil used to lubricate the glands. The leg is filled with air from a pump or air bottle attached to the filling valve until the pressure shown on the plate attached to the leg is reached. This pressure is given for the leg fully extended with no load. A measurement is also shown on the plate, indicating the length of piston rod from gland nut to joint with the bottom fitting to correspond with this pressure when the aeroplane is standing unladen.

When the aeroplane lands the first movement of the compression stroke compresses the air in the upper cylinder ; as this pressure increases it overcomes a spring behind the mushroom valve inside the piston and the valve opens and allows air to pass through previously determined size apertures into the annular space behind the piston. Considerable turbulence of air occurs which has an added effect of absorbing energy in addition to that obtained by the throttling of the air.

When the energy of the landing shock is absorbed the high pressure of air acting on the piston head returns the piston to the original position. It first has to displace the air which has been forced behind the piston during the compression stroke. The valve is closed by this returning air and the air can only return through a small hole in this valve.

This restriction of air on the return stroke has a damping effect, damping out oscillations.

The tyres are Dunlop 12 by 12 in. reinforced and wheels have ball bearings.

Tyre Pressures

The following is a schedule of recommended tyre pressures to cover a loading range between 9,000 lbs. and 11,000 lbs. :—

Laden Weight of Aeroplane. Lbs.	Inflation Pressure. Lbs. per sq. in.
12 by 12 in. tyres	
9,000	30
9,400	32
9,800	34
10,000	35
11,000	41
5·5 in. " Ecta " tail wheel	
10,000 (tail wheel load 1,090 lbs.)	37½
11,000 (tail wheel load 1,200 lbs.)	42

Note.—The maximum tail wheel load at 10,000 lbs. all-up weight is 1,090 lbs. and at 11,000 lbs. is 1,200 lbs.

Brakes

Bendix wheel brakes are fitted as standard.

Tail Wheel

The type 86 is fitted with a Dunlop 5·00–3½ in. heavy tail wheel tyre and the 86 A and 86 B with Dunlop A.W. 4 by 4 in. wheel with 5·5 in. " Ecta " tyre. The tail wheel has full castor action. The shock absorbing

Fig. 6.—DATUM LEVELLING BLOCKS ARE PROVIDED INSIDE THE CABIN ON THE FUSELAGE SIDE.

device consists of rubber blocks in compression encased in telescopic tubes. Particular attention has been paid to provide large bearing surfaces at moving points and lubricators for gun greasing are placed where required.

Smith's Electrical Gauge

The gauge consists of a float fixed to an arm which rises and falls with the level of the fuel in the tank. The movement of the float arm, by means of bevel gears, rotates a central spindle terminating in a fuel-tight box at the top of the tank. This box contains an electrical potentiometer, the moving arm of which is attached to the central spindle. When the switch on the instrument board is put in the appropriate position, a current is caused to flow through the potentiometer windings and a proportion of the battery voltage is measured on the indicator, the amount of which depending upon the position of the movable arm, which in turn is controlled by the level of the fuel.

Messrs. Smith's Aircraft Instruments explain that there is absolutely no risk of fire should fuel find its way to the resistance which is housed in the head of the tank unit. Normally, fuel does not enter the head of the unit as this part should be airtight and the air cushion contained therein prevents the fuel from entering.

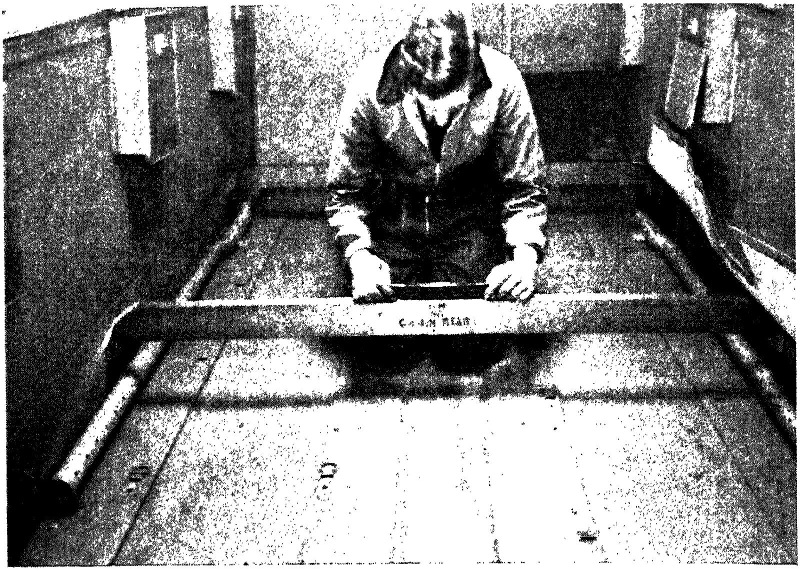


Fig. 7.—LATERAL LEVEL IS TAKEN ON BLOCKS ON EITHER FUSELAGE SIDE.

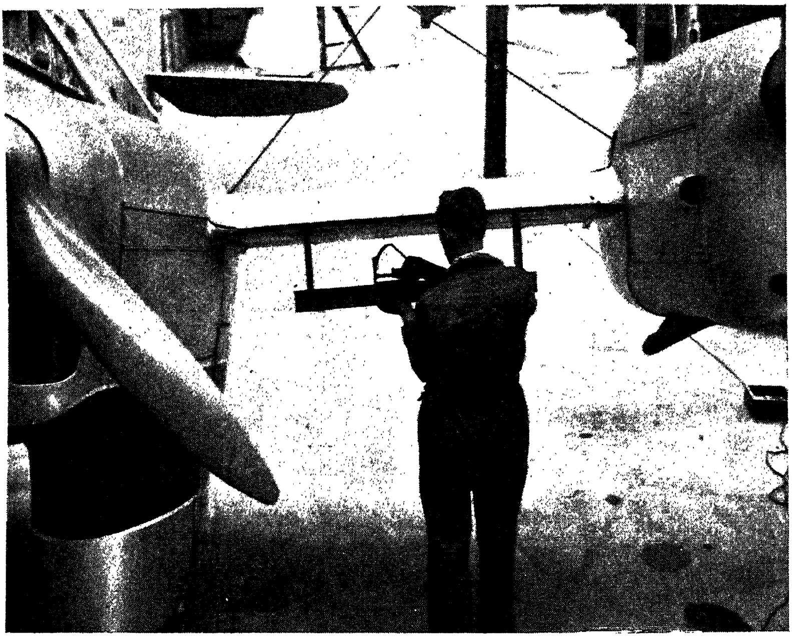


Fig. 8.—DIHEDRAL ANGLE IS MEASURED ON UNDERSIDE OF MAIN SPARS BY MEANS OF A "U"-SHAPED STRAIGHT-EDGE.

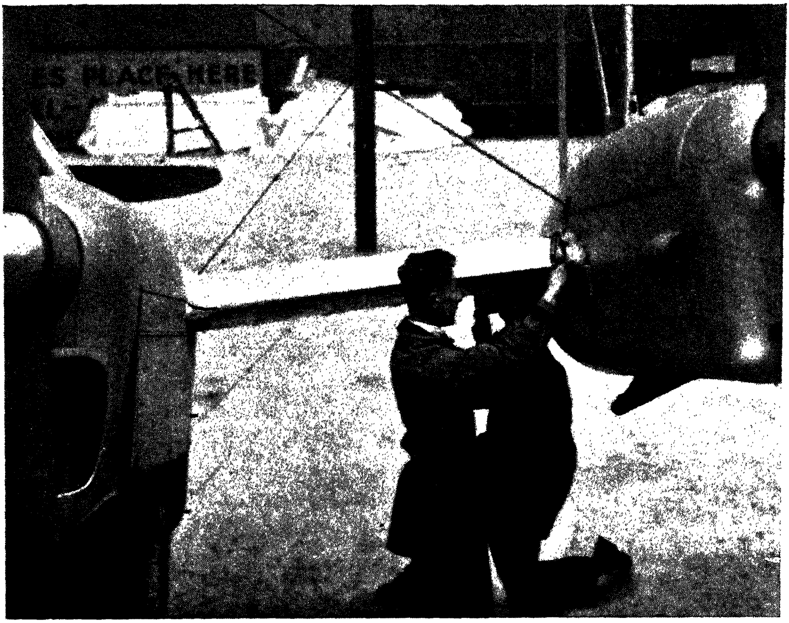


Fig. 9.—INCIDENCE IS MEASURED BY STRAIGHT-EDGE HELD *HARD* UP TO THE SPARS AND *PARALLEL* TO RIBS.

Should the top cover of the unit be removed for any reason, a suitable jointing compound should be used when refitting to make an airtight joint.

Flap Gear

The flap gear is the " Dowty " hydraulic system, comprising jacks on the wings to operate the flaps, a pump with control valve box in the pilot's cockpit. (Notes on the operation of the flap gear are given later.)

RIGGING INSTRUCTIONS

To assemble the aeroplane it is first necessary to support the fuselage on trestles.

Checking the Levels

Lateral and longitudinal levels can be checked by placing a level on blocks arranged for that purpose inside the cabin on the fuselage side. These blocks, together with the trestle points, are shown on rigging diagrams.

Fitting Bottom Stub Planes

The bottom stub planes should now be fitted to the fuselage. These

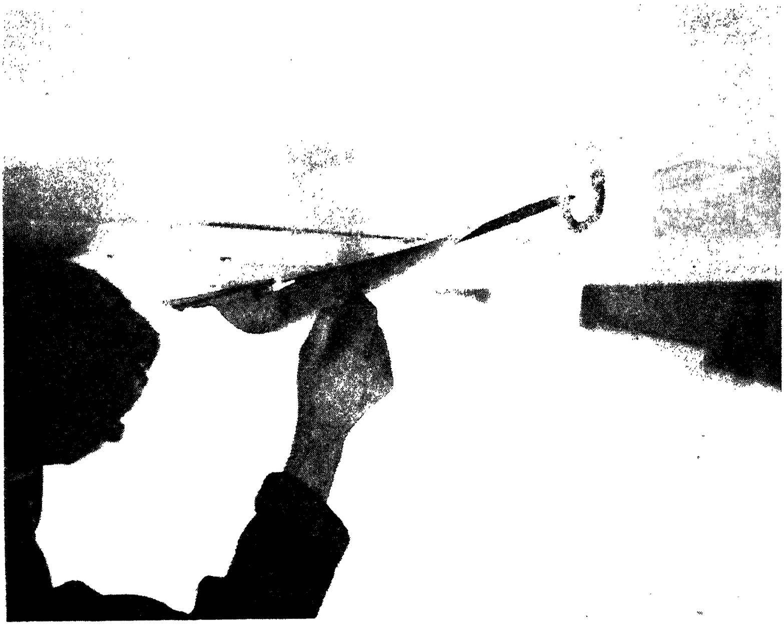


Fig. 10.—AILERON DIFFERENTIAL SETTING IS CHECKED WITH A STEEL RULE.

stubs are either made in halves to enable them to pass between the outside of the cabin floor and the bottom fabric stringers and joined together at the front and rear spars by a sleeve riveted to one half and bolted to the other, or, alternatively, the stubs are made in one complete unit, in which case the under fuselage fabric springers are detachable in way of the stub spars and rejoined by bolted-on U-plates after the stub is in position.

In a few cases these stringers have not been made detachable by the constructors as it was not considered these particular aeroplanes would be dismantled down to the bottom stub. If, however, this is found to be necessary for any reason, the stringers can be cut and rejoined.

Stub Planes

The spars of the stubs are attached to the fuselage by split brackets on the bottom longerons and by bolts through the wooden members under the cabin floor.

Diagonal Struts

The diagonal struts should now be fitted. With the diagonal struts in position the stub plane will be self-supporting but care should be taken to trestle up assembled parts to avoid tipping the fuselage.

The Chassis

The complete chassis can now be fitted. Being a rigidly braced structure, no adjustments are provided. To ensure that the chassis has been correctly assembled, as a check, dimension can be taken between the tyres—a difference of ¾ in. between the measurements taken fore and aft of the wheel centres is permissible.

Engine Mounting and Bulkhead

The inboard engine mounting and bulkhead, also the engine and tanks, can now be attached. The bottom intermediate plane is next bolted up to the bottom stub plane and the fireproof bulkhead and engine fitted. At this stage the outboard engine oil tank can be attached. Care should be taken that the plane is safely trestled.

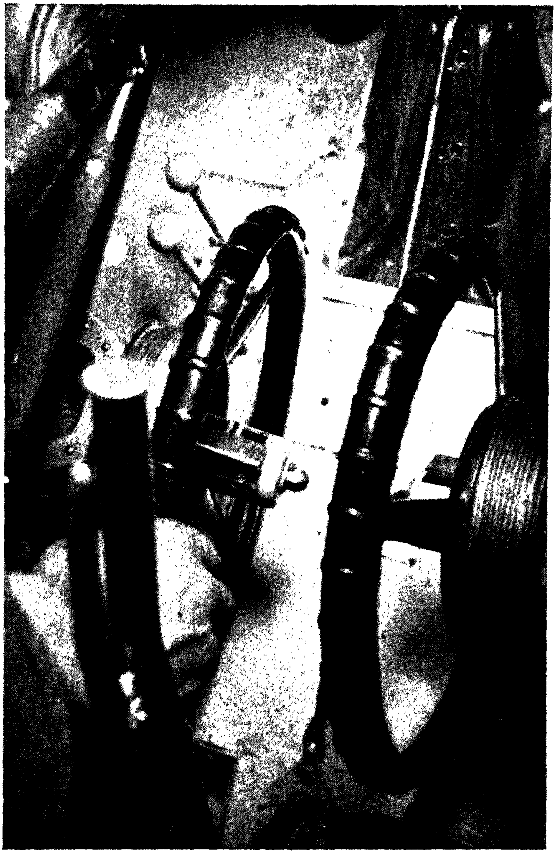


Fig. 11.—SETTING TAIL PLANE VARIABLE INCIDENCE GEAR (1). First set control wheel to neutral.

Interplane Struts

The front and rear intermediate interplane struts should now be fitted to the top stub plane before assembling this plane to the fuselage fittings, which operation can now be carried out.

Landing Wire

The inner landing wire should now be fitted and tensioned up to an approximate position, followed by the attachment of the diagonal strut

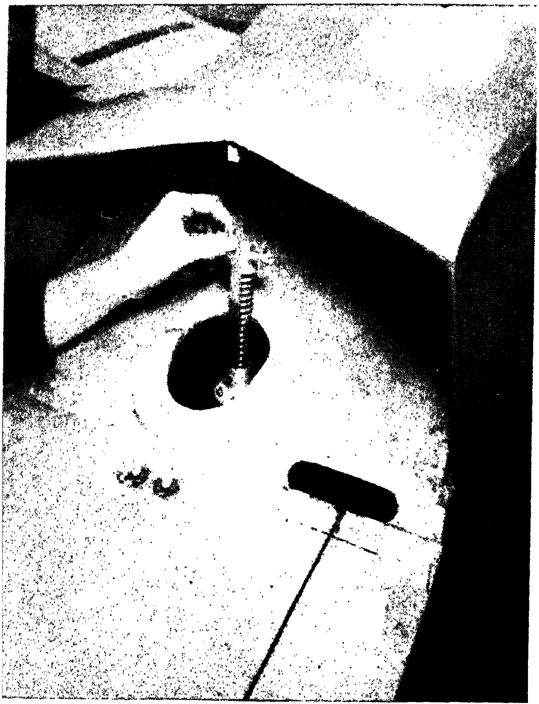


Fig. 12.—SETTING TAIL PLANE VARIABLE INCIDENCE GEAR (2).

Set the variable incidence jack ready for tail plane attachment.

between the front and rear interplane struts. This diagonal strut is fitted with adjustable ends as a means of adjusting the incidence.

Bottom Extension Plane

The bottom extension plane is next assembled to the bottom intermediate plane, followed by the outer landing wire.

Outer Interplane Strut

The outer interplane strut is now fitted in position to the top extension plane and this plane then assembled to the top stub plane. The outer interplane strut is fitted with adjustable ends as a means of adjusting the incidence.

Flying Wires

The inner and outer flying wires are attached and tensioned up to an approximate position.

Trueing Up

The planes are now completely in position and ready for trueing up. Before carrying out this operation the level of the fuselage should be checked and readjusted, if necessary.

For general information the rigging diagrams can be consulted, but the actual angles to which a particular aeroplane was passed out by the constructor should be worked to and are given in the Log Book.

Care should be taken when rigging to ensure that the main flying and landing wires are not over-tensioned to the extent of bowing the main plane spars. It will be appreciated that large wires can be tightened to an excessive degree far in excess of that required to obtain the correct

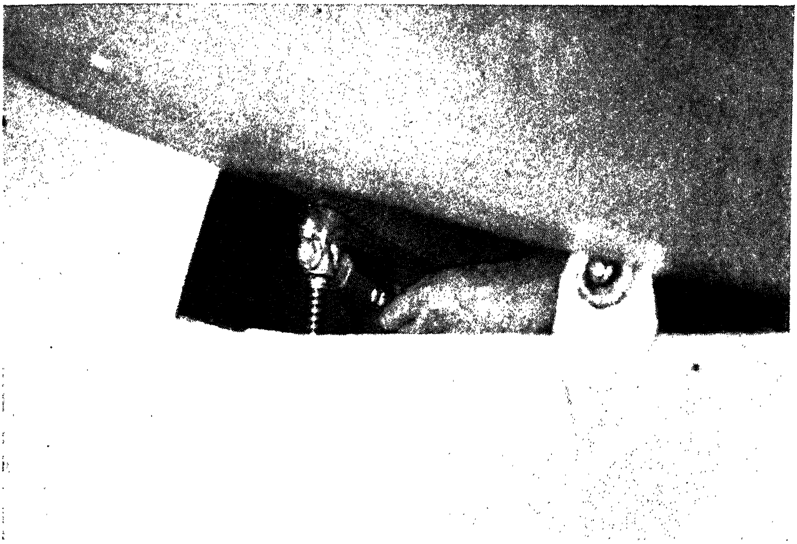


Fig. 13.—SETTING TAIL PLANE VARIABLE INCIDENCE GEAR (3).
Fitting front of tail plane to variable incidence jack.

rigging. If any difficulty is experienced, the rigging is probably at fault and a careful check should be made throughout.

Tail Unit

The tail plane is attached to the fuselage at the front spar by the adjustable screw gear and at the rear spar by means of a double fork end fitting and special pins.

The complete tail plane should be assembled first to the aeroplane and its control cables joined up. The fin is then assembled by fitting the pivot on the base of the fin post in its socket at the rear end of the fuselage. The forward end is bolted to the trunnion on the fin adjusting sleeve. The bracing wires from the top of fin post to tail plane and from tail plane to fuselage are then fitted.

The rudder can now be fitted to the fin post.

Special care is necessary when carrying out the rigging adjustment to ensure that the tail plane bracing wires will be adequately tensioned for the whole range of the tail plane incidence. In order that this procedure may be carried out, the tail plane should be set in the neutral position as determined from the indicator adjacent to the tail plane adjuster wheel and all external bracing wires adjusted to the normal tension. Care should be taken to ensure that the wiring plates on the rear spar of the tail plane taking the external bracing wires are free to swivel on the fixing plate.

"*Rear* diagonal struts from top of fuselage to inboard engine mounting for D.H.86A machines with a Certificate of Airworthiness with a total permissible weight of 11,000 lbs must be Part Nos. 59951 L.H. and 59952 R.H. For ease of identification these struts will have a red painted band at the lower end which is under the engine cowling."

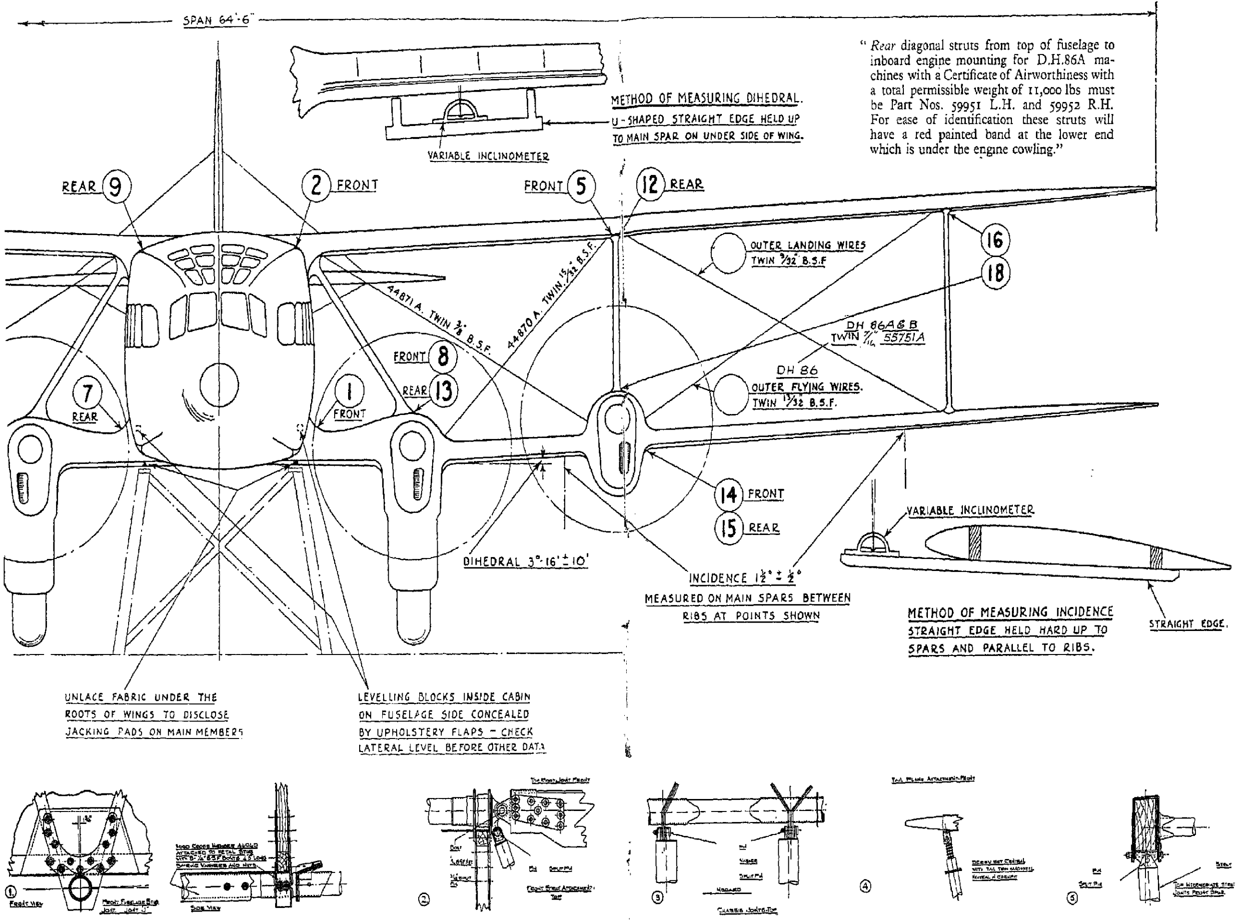

SPAN 64'-6"
METHOD OF MEASURING DIHEDRAL.
U-SHAPED STRAIGHT EDGE HELD UP TO MAIN SPAR ON UNDER SIDE OF WING.
VARIABLE INCLINOMETER
REAR 9
2 FRONT
FRONT 5
12 REAR
16
18
OUTER LANDING WIRES TWIN 9/32" B.S.F
44871 A. TWIN 3/8" B.S.F.
44870 A. TWIN 15/32" B.S.F.
DH 86A & B TWIN 7/16" 55751A
DH 86
OUTER FLYING WIRES. TWIN 13/32" B.S.F.
FRONT 8
REAR 13
7 REAR
1 FRONT
14 FRONT
15 REAR
VARIABLE INCLINOMETER
DIHEDRAL 3°-16' ± 10'
INCIDENCE 1½° ± ½°
MEASURED ON MAIN SPARS BETWEEN RIBS AT POINTS SHOWN
METHOD OF MEASURING INCIDENCE
STRAIGHT EDGE HELD HARD UP TO SPARS AND PARALLEL TO RIBS.
STRAIGHT EDGE.
UNLACE FABRIC UNDER THE ROOTS OF WINGS TO DISCLOSE JACKING PADS ON MAIN MEMBERS
LEVELLING BLOCKS INSIDE CABIN ON FUSELAGE SIDE CONCEALED BY UPHOLSTERY FLAPS - CHECK LATERAL LEVEL BEFORE OTHER DATA
①
②
③
④
⑤

Fig. 14.—RIGGING DATA (1).

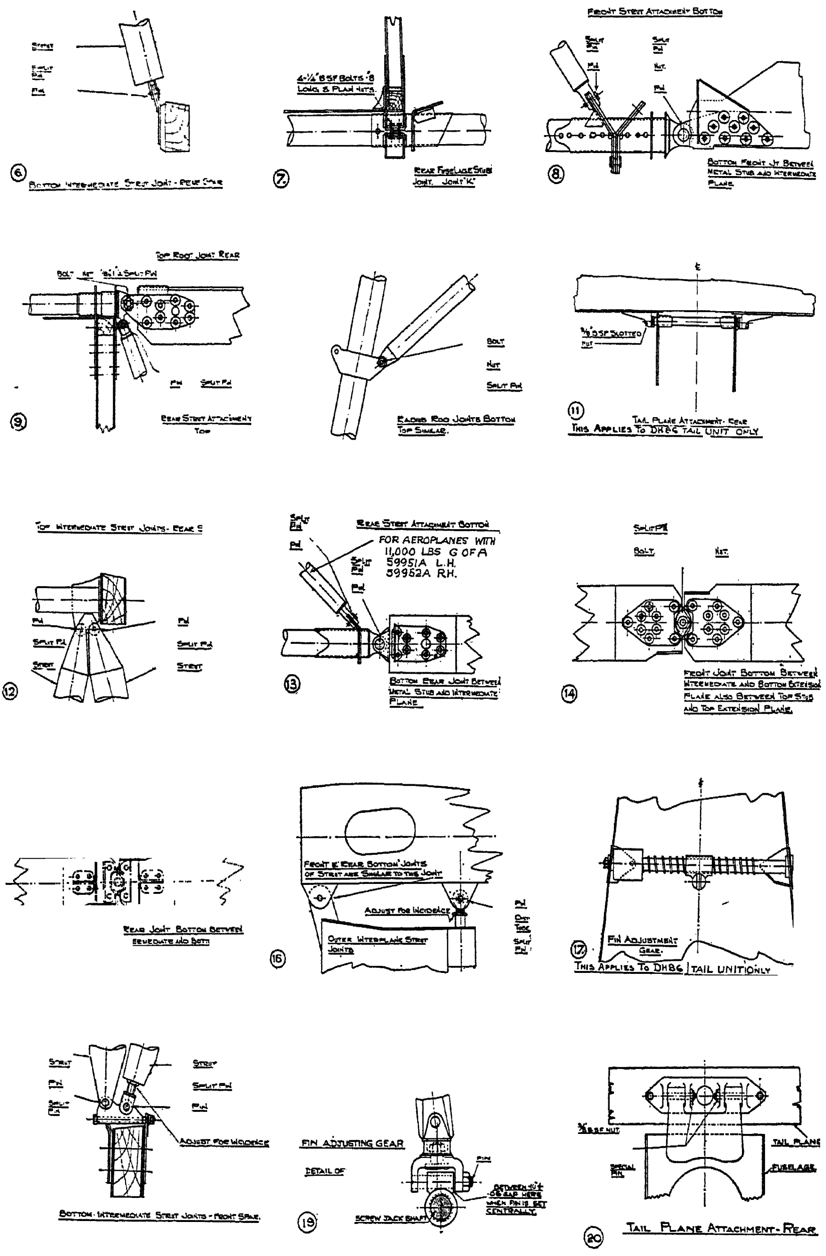

Strut
Split Pin
Pin
⑥
Bottom Intermediate Strut Joint - Rear Spar
4-¼" BSF Bolts 8" Long & Plain Nuts.
⑦
Rear Fuselage Stub Joint. Joint "K"
Front Strut Attachment Bottom
Split Pin
Pin
Split Pin
Nut
Pin
⑧
Bottom Front Jt Between Metal Stub and Intermediate Plane
Top Root Joint Rear
Bolt Nut ... & Split Pin
Pin Split Pin
⑨
Rear Strut Attachment Top
Bolt
Nut
Split Pin
Radius Rod Joints Bottom Top Similar.
℄
⅜" BSF Slotted Nut
⑪
Tail Plane Attachment - Rear
This Applies To DH86 Tail Unit Only
Top Intermediate Strut Joints - Rear S
Pin
Split Pin
Strut
Pin
Split Pin
Strut
⑫
Split Pin
Pin
Rear Strut Attachment Bottom
FOR AEROPLANES WITH 11,000 LBS G OF A 59951A L.H. 59952A RH.
Split Pin
Pin
⑬
Bottom Rear Joint Between Metal Stub and Intermediate Plane
Split Pin
Bolt
Nut
⑭
Front Joint Bottom Between Intermediate and Bottom Extension Plane also Between Top Stub and Top Extension Plane.
Rear Joint Bottom Between ...ermediate and Bott...
Front & Rear Bottom Joints of Strut are Similar to this Joint
Adjust for Incidence
Outer Interplane Strut Joints
Pin
Dist Tube
Split Pin
⑯
℄
Fin Adjustment Gear.
⑰
This Applies To DH86 Tail Unit Only
Strut
Pin
Split Pin
Strut
Split Pin
Pin
Adjust for Incidence
Bottom Intermediate Strut Joints - Front Spar.
FIN ADJUSTING GEAR
DETAIL OF
Pin
Between ·01" + ·05" Gap Here When Fin is Set Centrally.
Screw Jack Shaft
⑲
⅜" BSF Nut.
Tail Plane
Special Pin
Fuselage
⑳
Tail Plane Attachment - Rear

Fig. 15.—RIGGING DATA (2).

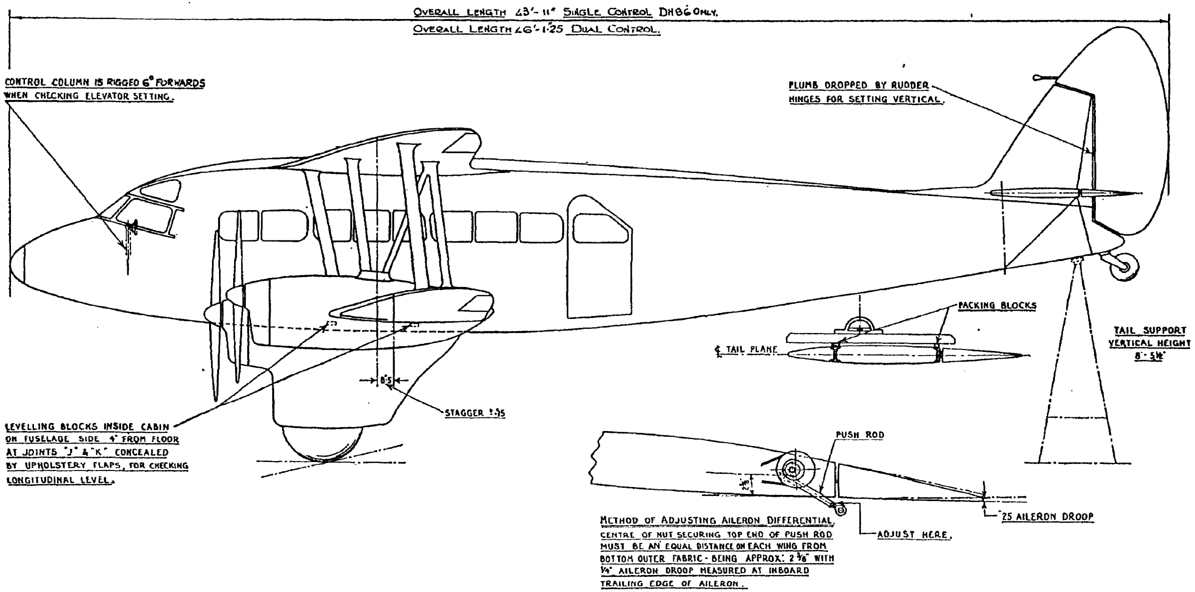

OVERALL LENGTH 43'-11" SINGLE CONTROL DH86 ONLY.
OVERALL LENGTH 46'-1·25 DUAL CONTROL.
CONTROL COLUMN IS RIGGED 6° FORWARDS WHEN CHECKING ELEVATOR SETTING.
PLUMB DROPPED BY RUDDER HINGES FOR SETTING VERTICAL.
PACKING BLOCKS
℄ TAIL PLANE
TAIL SUPPORT VERTICAL HEIGHT 8'-5½"
8·5"
STAGGER 1·35
LEVELLING BLOCKS INSIDE CABIN ON FUSELAGE SIDE 4" FROM FLOOR AT JOINTS "J" & "K" CONCEALED BY UPHOLSTERY FLAPS, FOR CHECKING LONGITUDINAL LEVEL.
PUSH ROD
2⅜"
ADJUST HERE.
·25 AILERON DROOP
METHOD OF ADJUSTING AILERON DIFFERENTIAL.
CENTRE OF NUT SECURING TOP END OF PUSH ROD MUST BE AN EQUAL DISTANCE ON EACH WING FROM BOTTOM OUTER FABRIC - BEING APPROX: 2⅜" WITH ¼" AILERON DROOP MEASURED AT INBOARD TRAILING EDGE OF AILERON.

Fig. 16.—RIGGING DATA (3).

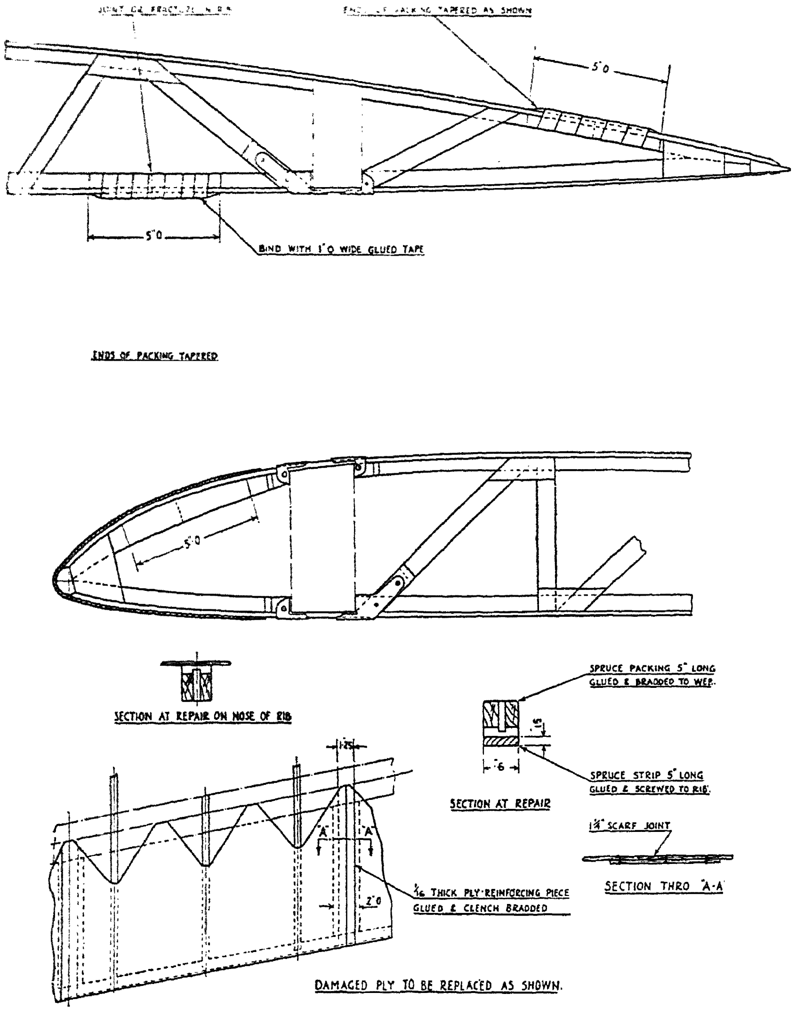
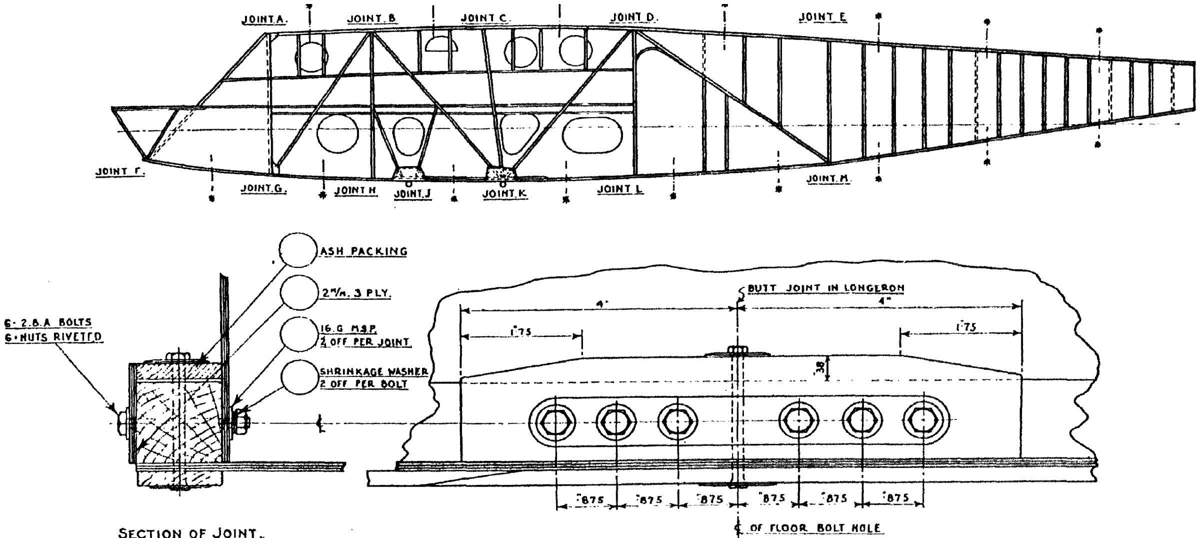

JOINT OR FRACTURE IN RIB
ENDS OF PACKING TAPERED AS SHOWN
5"0
5"0
BIND WITH 1"0 WIDE GLUED TAPE
ENDS OF PACKING TAPERED
5"0
SECTION AT REPAIR ON NOSE OF RIB
SPRUCE PACKING 5" LONG GLUED & BRADDED TO WEB.
·15
·6
SPRUCE STRIP 5" LONG GLUED & SCREWED TO RIB.
SECTION AT REPAIR
1·25
1¼" SCARF JOINT
'A' 'A'
SECTION THRO 'A-A'
1/16 THICK PLY-REINFORCING PIECE GLUED & CLENCH BRADDED
2"0
DAMAGED PLY TO BE REPLACED AS SHOWN.

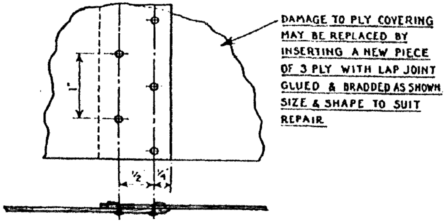
Fig. 17.—Details of repairs to ribs.

Important Note

The foregoing instructions with regard to the tail plane bracing wires should be carefully observed, as over-tensioning affects the free working of the fin bias gear. When the tail unit is rigged and fin bias gear completely assembled a small clearance from 0·10 to 0·06 in. should exist between the rear of the screwed sleeve and the rear of the slot in the fork-end fitting when the fin is in the neutral, that is, the central position.



FULL SIZE VIEW OF JOINT IN LONGERON AT *


DAMAGE TO PLY COVERING MAY BE REPLACED BY INSERTING A NEW PIECE OF 3 PLY WITH LAP JOINT GLUED & BRADDED AS SHOWN SIZE & SHAPE TO SUIT REPAIR
1"
½"
¼"

IMPORTANT NOTES.

Damaged longerons may be cut out between joints marked thus * and a new length inserted between any two points, joined as in full size view. When longerons are damaged it is also important to inspect the joints, and if the slightest doubt of their soundness exists a new length of longeron should extend through the joint. New lengths of longeron are of spruce to Specification D.T.D. 36.A. Joint plates are of 16G mild steel-plate to Spec. S.3. Failing this the tensile strength should not be less than 26 tons per sq. in. Bolts should be mild steel to Spec. S.1. Failing this the tensile strength should not be less than 35 tons per sq. in. 3-ply should be of a good quality commercial 1·5 m.m. Packing blocks are of good quality ash, glued and screwed to the longerons with four 1 in. No. 5 wood screws. All outside faces and edges of 3-ply to be covered with madapolam or low grade cotton fabric doped on.

Fig. 18.—DETAILS OF REPAIRS TO FUSELAGE.

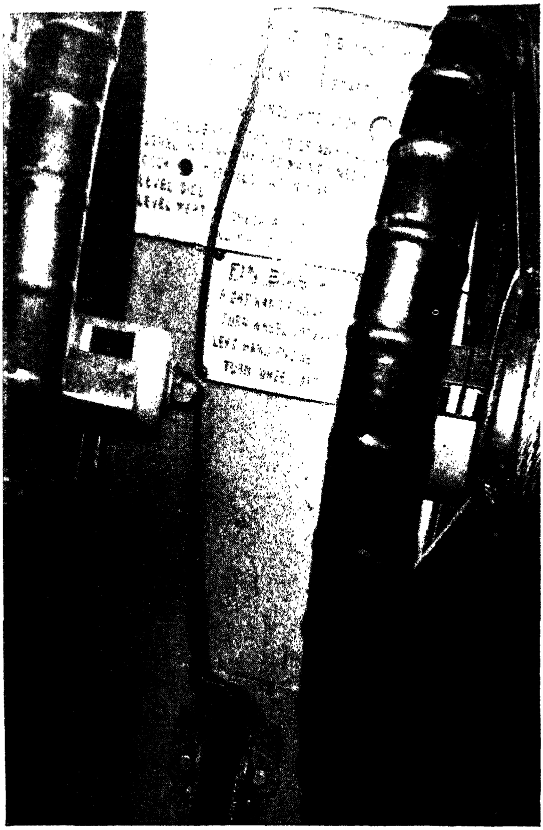


Fig. 19.—SETTING FIN BIAS GEAR (1).
First set control wheel at neutral.

It will be readily appreciated that in this position the front bottom fin attachment is in its most forward condition, and as the fin is wound from side to side the attachment will travel backwards in the sleeve.

Special Rigging of Early Models

The first batch of D.H. 86 A's were issued with the D.H. 86 type tail unit, in which case when it is rigged and the fin bias gear completely assembled a small clearance up to 0·06 in. should exist between the front of the eye-bolt and the front of the slot in the screwed traversing sleeve when the fin is in the neutral position.

The attachment of the tail plane at the front spar is by means of an adjustable screw gear as shown, and at the rear spar by means of a bolt passing through the pivot bracket and clamping on to a distance tube passing through the bearings on the fuselage. Shims in the form of AGS.160/F. washers are used between the fuselage bearings and the tail plane pivot brackets to take up side play.

The complete tail plane should be assembled first to the aeroplane and its control cables joined up. The fin is then bolted to the bracket on the stern post and at the forward end to the raised structure at the rear of the fuselage. The rudder should now be attached to the fin post.

Differential Aileron Control

Should the setting of the differential pulley in the bottom planes be

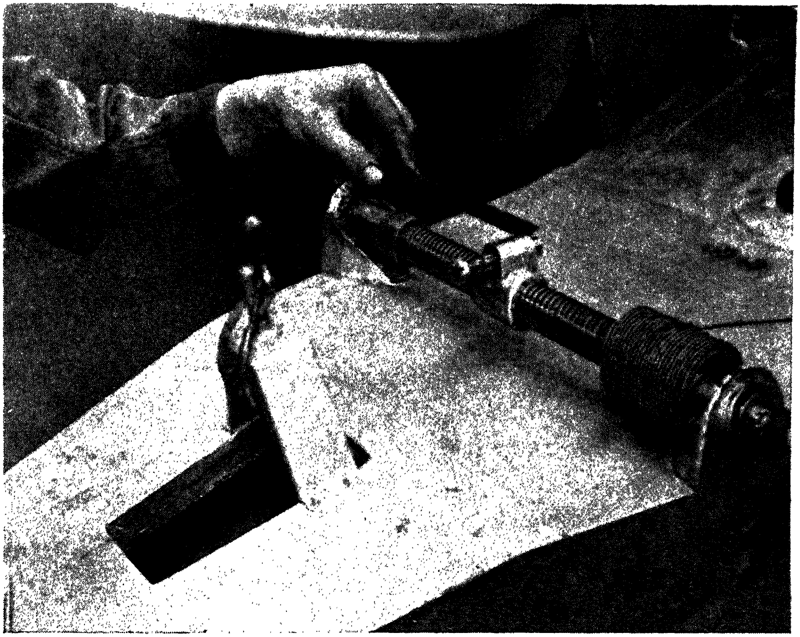


Fig. 20.—SETTING FIN BIAS GEAR (2).
Next set screwed collar for fin attachment.

disarranged for any reason, such as the dismantling and reassembly of planes, care must be taken to reassemble as before. This can be conveniently done by means of a steel rule inserted between the two wooden beams to read required measurements of $2\frac{5}{8}$ in. (distance between crank and bottom of beam), as shown on rigging diagram. This dimension should be read with the control wheel neutral and allowing a droop of approximately 0·25 in. at the trailing edge of the aileron.

The aileron push-rod between crank-pin and aileron lever is adjustable but, once set, should not be altered unless for reasons outlined below. (The above remarks appertain to both sides of the aeroplane.)

A Rigging Fault and the Remedy

If the aeroplane shows a tendency to fly one wing low, first check the rigging of the wing structure and note if differential setting is correct. Should these be found in order the trouble may be due to slight warping of the aileron spars.

Rectification should be made in the following manner :—

(*a*) Disconnect both push-rods between crank pin on pulley and aileron lever.

(*b*) Lengthen the push-rod on the side which tends to fly low by

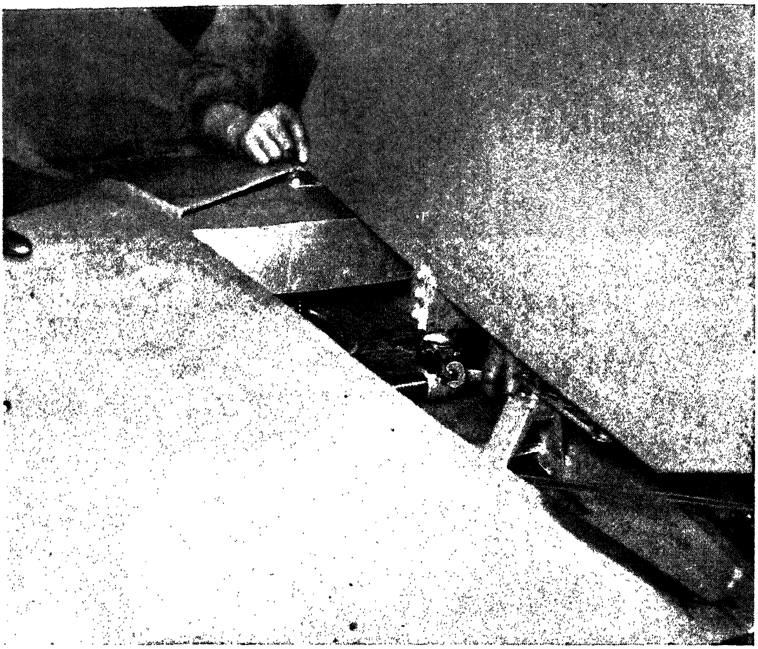


Fig. 21.—Setting fin bias gear (3).
Fitting front attachment of fin.

unscrewing the adjustable end by one turn, shortening the rod on the other side by a corresponding amount.

(*c*) Reconnect the push-rods.

If this adjustment proved insufficient to correct the trim of the aeroplane, the operation should be repeated until the fault is overcome. Care should be taken not to attempt to put an incorrectly rigged aeroplane in order by this means. It should never be necessary to shorten or lengthen the adjustable push-rods by more than two or at the most three turns.

Notes on Operation of Flap Gear

1. The reservoir should be filled with Wakefield's " Hydraulic " fluid diluted with paraffin in the ratio of 5 to 1. (The fluid described above must not be confused with another fluid marketed by Wakefield's called " Castdraulic," which fluid is a powerful dope solvent and must not be used under any circumstances.) It is not considered necessary to bleed the system. After the reservoir has been filled and the pump operated a few times a small amount of oil may come out of the vent in the filler cap. This is not detrimental as the pump will function satisfactorily with the reservoir half-full of oil.

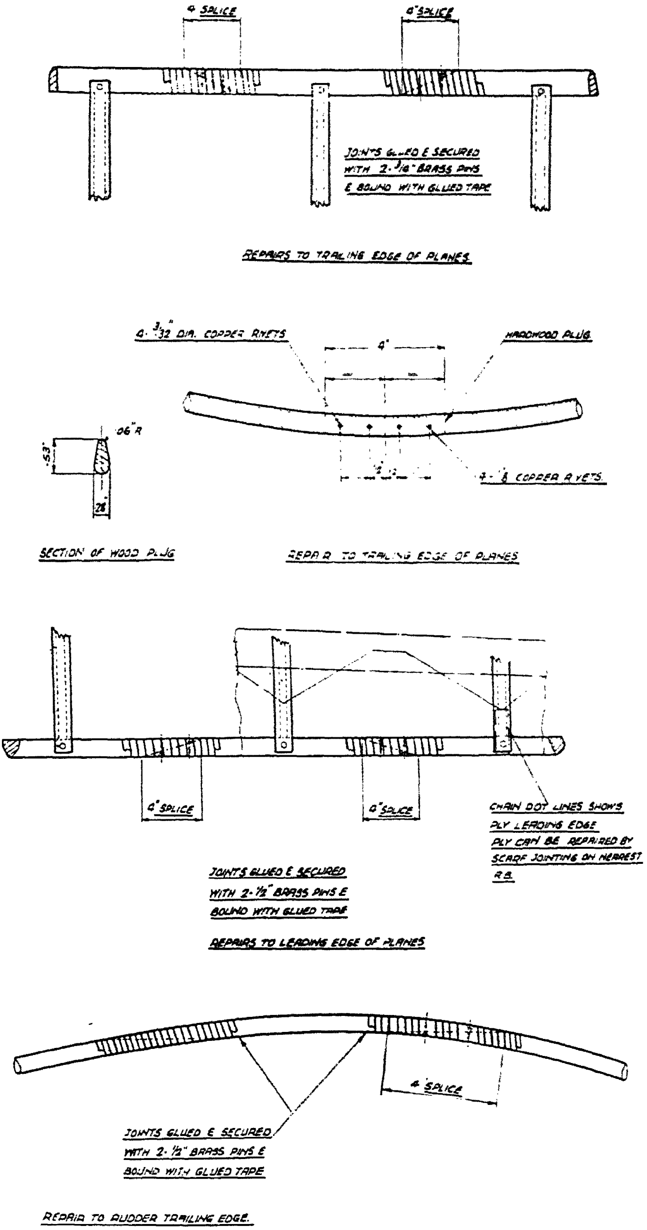


Fig. 22.—DETAILS OF LEADING AND TRAILING EDGE REPAIRS.

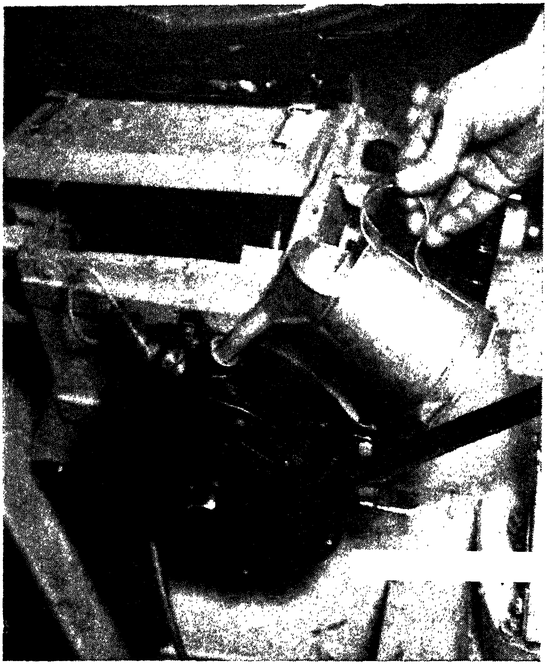
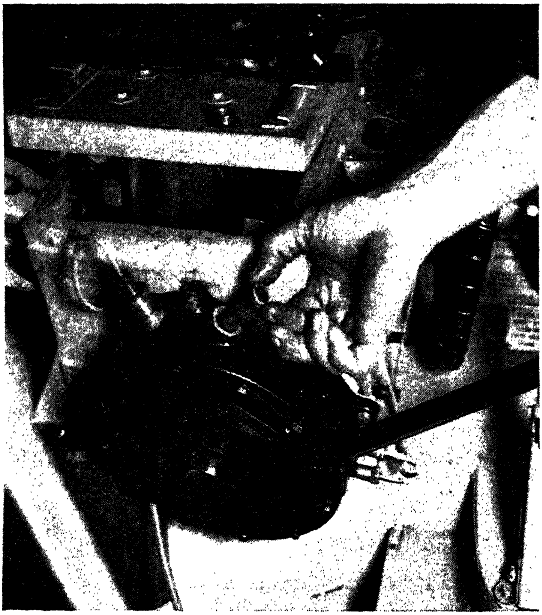


Fig. 23.—Flap gear

Filling the pump
servoir after removing
l



g. 24.—Flap gear
(*right*).

The filters in the flap
stem should be cleaned.

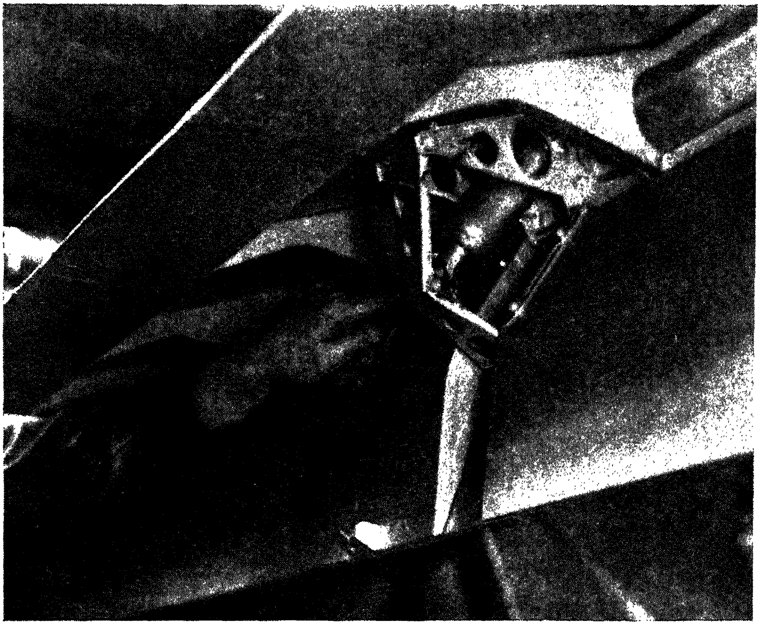


Fig. 25.—ADJUSTING FLAP JACK.

2. The hydraulic jacks on the wings which operate the flaps are provided with an adjustable end. It is most important when adjusting the length of the jack before connecting up the links to make sure that the piston is at the limit of its outward travel. With the piston in this position, the length should be adjusted so that when the flap links are connected up the flap is in the closed position against the stops on the ribs. The flap should not come up against its stop before the piston has reached its limit of travel.

3. The flaps are intended to be operated at an air speed of 80 to 90 m.p.h.

4. *To Lower Flaps.*—Put lever on valve box to "down" position and pump. When the flaps are down the pump becomes hard to operate and should not be forced.

5. *To Raise Flaps.*—Put lever on valve box in "up" position. The flaps will then blow up without pumping to within approximately 2 in. of the closed position. They may then be fully closed by a few strokes of the pump.

Special Note.—A drip tray is fitted to the floor of the pilot's cockpit under the flap operating pump to catch any leakage or overflow from the pump. This tray should be cleaned out periodically to ensure that spilt fluid does not accumulate.

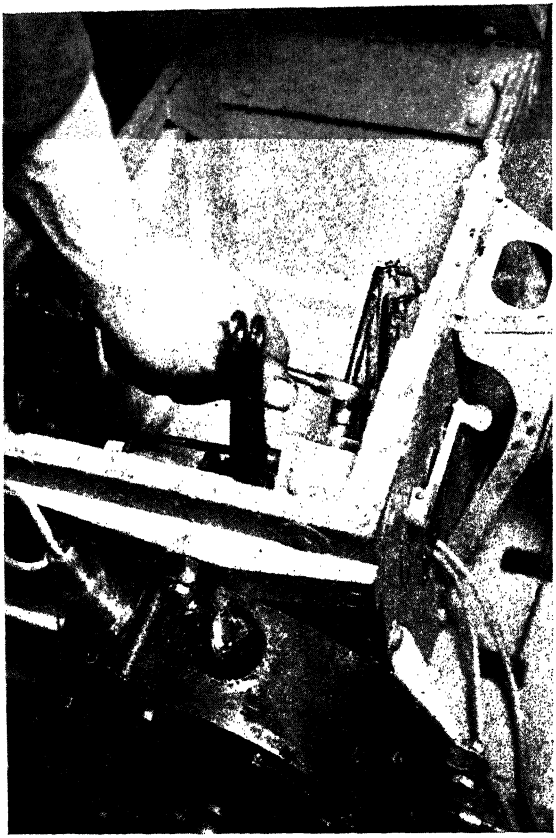


Fig. 26.—CHECKING CONNECTION ON FLAP CONTROL BOX. The unions are being checked for tightness.

Bendix Brake Adjustment—Major Adjustment

Note.—This adjustment is only necessary for initial setting of the operating cables at the works, or if the chassis has been dismantled or when new shoes are fitted.

1. Jack up aeroplane and remove wheels.

2. Approximately centralise shoes.

3. With the hand-brake in the " off " position no movement of the rudder bar is transmitted to the cables and they run slack. By pulling the hand-brake lever " on " this slackness is taken up and the brakes commence to operate after any desired movement of the rudder bar. If the hand-brake lever is pulled full " on " a differential brake action is still possible.

4. With the hand-lever in the " off " position, adjust the turnbuckles on the brake operating cable so that the operating cam in the brake is just touching the shoes without actually expanding them. The wheel should then be put into place.

5. It should now be ascertained if the brakes are free when the rudder is centralised and also that full rudder movement is obtained in both directions.

6. Any stretch which may occur on the cable can be taken out by the turnbuckle. This adjustment should not be used to take up wear, for which see below.

The ratchet on the hand-lever is self-engaging and is released by pressing trigger at top of the lever.

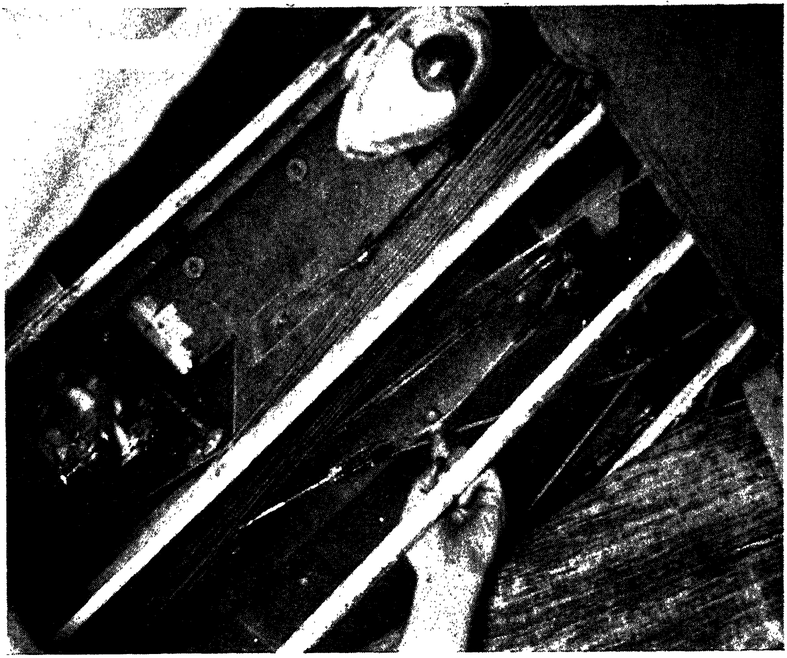


Fig. 27.—Setting and adjusting brake gear (1).

With the hand-brake full off there should be sufficient slack in the cables to allow full rudder movement.

Adjustment for Wear

This is carried out by rotating the star-wheel by means of a screwdriver inserted in the slot provided and the hand should move inwards towards the axle to expand the brake by using the slot in the casting as a fulcrum.

Caution.—The adjusting turnbuckles must not be used to take up linings, but only for initial setting or to compensate for any stretch in cables. Stretch should be negligible as the cables are proof-loaded to half their breaking strength before fitting.

ROUTINE INSPECTION AND MAINTENANCE

The following covers broadly the points to be observed, and from this the engineer can develop his more detailed schedule to suit the particular needs of the operating conditions involved.

Before Each Day's Flying

1. Attention to pilot's previous reports.
2. Inspect airscrews.

3. Inspect all covered surfaces for indications of damage.
4. Check all controls for free movement and normal operation.
5. Inspect undercarriage, tail wheel and fuselage attachments for any signs of abnormal landing stresses.
6. Inspect wires, struts and structure generally for any signs of abnormal flying stress.
7. Inspect engines and installations to ensure no slacking, displacement, chafing or leaks and rotate "Auto-Klean" filters.
8. Check fuel pumps independently by operating priming levers.
9. Run engines.
10. Verify engine cowlings are properly fastened.
11. Check accumulators for acid level and tightness of vents.

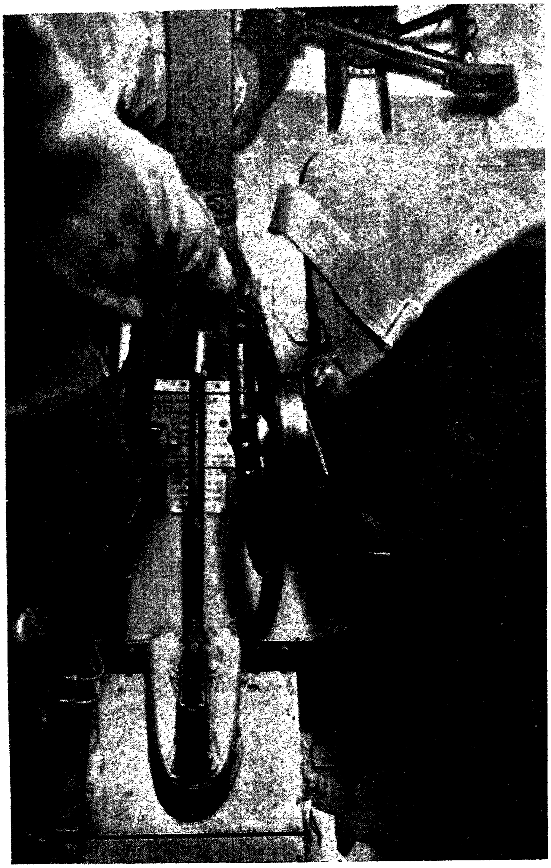


Fig. 28.—SETTING AND ADJUSTING BRAKE GEAR (2).
The rudder bar is being pushed hard over to see if there is sufficient slack in the cables.

After a Bad Landing

1. Examine shock-absorber leg units, axles and radius rods. If any signs of bowing are apparent, components affected should be replaced, as strength is impaired.
2. Examine wheels.
3. Examine attachment joints to main structure, verifying that no displacement, partial shear of pins or elongation of holes has occurred.
4. Examine fuselage members forming the structure between attachment joints, tail wheel gear and adjacent fuselage structure. Rucking

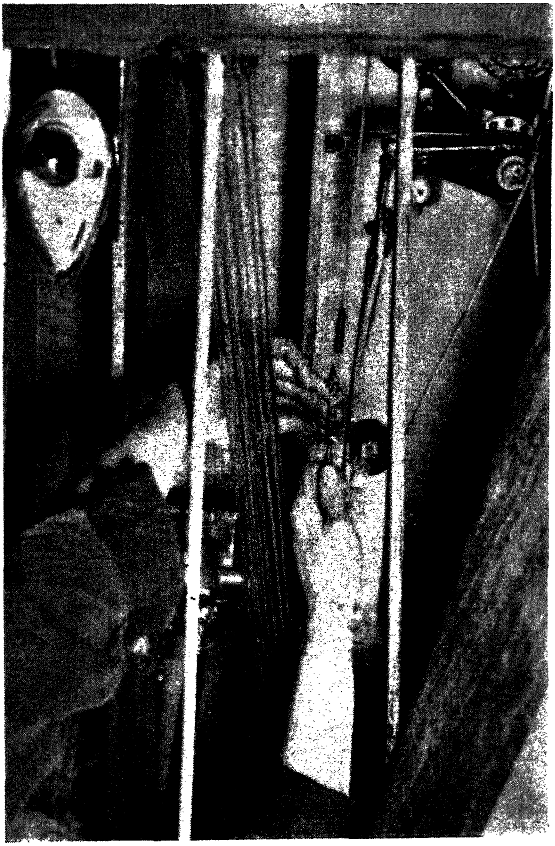


Fig. 29.—SETTING AND ADJUSTING BRAKE GEAR (3). Showing adjustment for stretch in cables.

of fabric or plywood and cracking of paint are indications that opening-up is advisable.

5. If the wing tip has come forcibly into contact with the ground or other object, the most likely place in which to look for damage is at or around the point of attachment of the main interplane struts and the root-end attachment joint to the centre plane structure. In the case of the rear spar look also at end around the inner aileron hinge fitting and at the ends of the packings on spar at interplane struts. These points can be examined by making small incisions in the fabric covering, which must, of course, afterwards be sewn up and covered with doped-on frayed edge patches at least 1 in. larger all round than the size of the cut.

Special Note

The portion of the front spars immediately behind the outboard engines, which is a large section of spruce with hardwood packings, is subjected to a certain amount of engine heat and a rather large initial shrinkage may be expected in the first few hours' operation. On this account, the bolts through the spars and attachment fittings should receive rather special attention to ensure that they are maintained at firm tension,

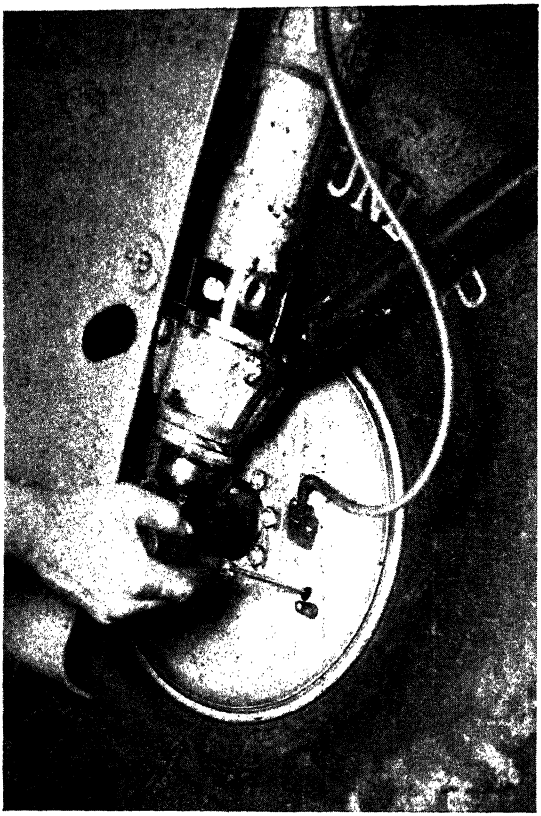


Fig. 30.—SETTING AND ADJUSTING BRAKE GEAR (4).
The star wheel is being rotated by means of the screwdriver.

Accumulators

The general necessity for installing accumulators in modern aeroplanes makes it desirable to draw attention to the vigilance which is essential to ensure the non-spilling of acid. Accumulators used are of an approved non-spillable type, but it must be understood that when under charge the acid may be under violent agitation and will escape unless correct levels (as per instructions on lid) are maintained and vent and filling stoppers are kept tight and rubber washers in good condition. Cases have occurred of extensive damage to airframe structure with grave effects on airworthiness due to lack of attention to and appreciation of this matter.

The accumulator fitted is primarily intended for lighting and wireless and should only be used for starting purposes in extreme emergency. This can only be used after closing the switch in the accumulator circuit. Normally, a portable ground accumulator should be plugged in, for which provision is made. Failure on the part of operators to provide and insist on the use of ground starting accumulators will result in unsatisfactory operation of the other electrical services.

The exhaust units of the 86 A and 86 B, cabin heater system, can be inspected at the 25-hour schedule by releasing the clamping ring at the forward end of the muff and withdrawing the exhaust pipe. It must be appreciated that any crack in the exhaust pipes within the muff may result in exhaust fumes entering the cabin through the heating system.

After every Twenty-five Hours' Flying

1. Inspection by licensed ground engineer, including the removal of all engine cowling and inspection covers and fabric lacings to facilitate an efficient examination of airframe, controls, airscrews, instruments, electrical equipment, engines and installation.
2. Cleaning and protective measures against deterioration and corrosion.
3. Lubrication of working parts.
4. Check and adjust tyre pressures.
5. Check valve clearances and reset, if necessary.
6. Dismantle, clean, reset points, and pressure test sparking plugs.
7. Clean suction and pressure oil filters. (Where "Auto-Klean" pressure oil filter is fitted, rotate—this need only be completely dismantled every 250 hours.)
8. Clean fuel filters and drain sumps of fuel tanks.
9. Remove and check carburetter jets and flush through float chamber, including pipe-lines between filter and carburetter.
10. Check contact-breaker gaps and clean distributors.
11. Drain oil system and fill with new oil.
12. Before replacing valve gear covers add engine oil to bring up to the level of ring on vent pipe.

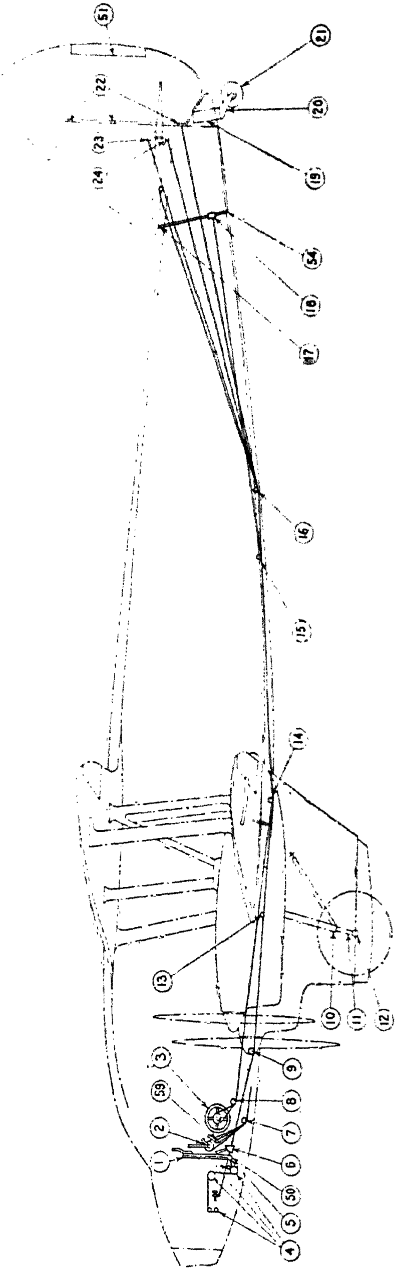
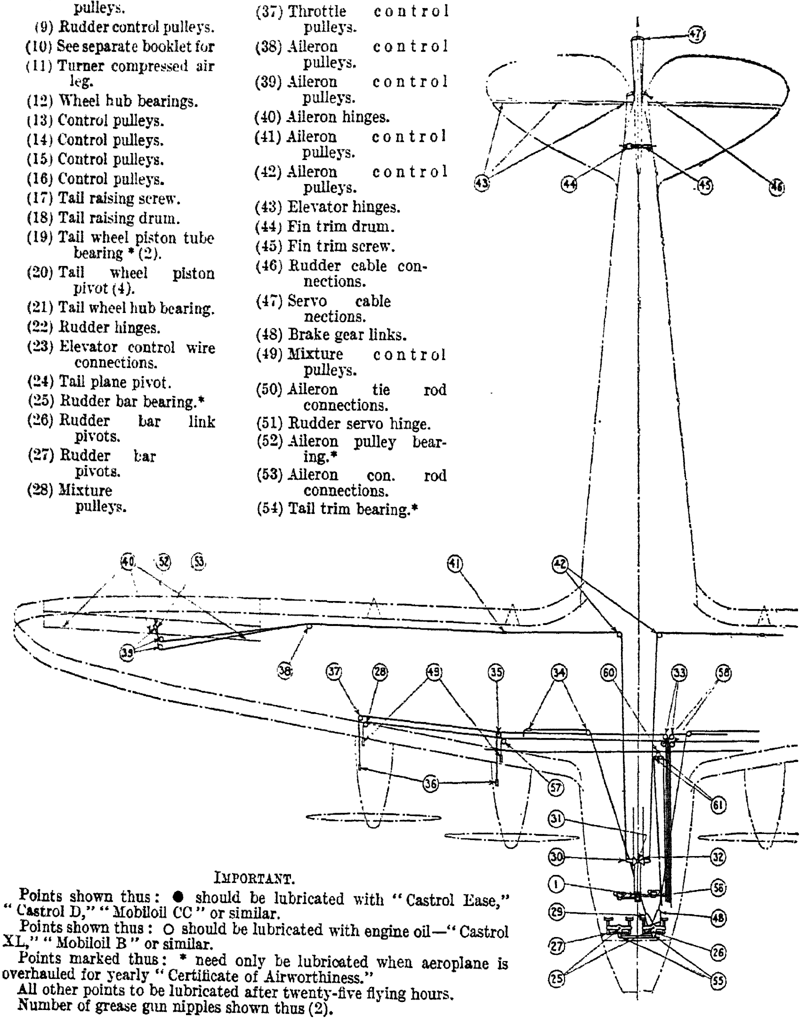


Fig. 31A.—LUBRICATION DIAGRAM. (See also Fig. 31B.)

(1) Control column head and chain.
(2) Throttle control drum and spindle.
(3) Tail and fin trim drums and spindles.
(4) Brake gear pulleys.
(5) Aileron sprocket and chain.
(6) Brake lever and ratchet.
(7) Throttle and mixture control pulleys.
(8) Tail and fin trim pulleys.
(9) Rudder control pulleys.
(10) See separate booklet for
(11) Turner compressed air leg.
(12) Wheel hub bearings.
(13) Control pulleys.
(14) Control pulleys.
(15) Control pulleys.
(16) Control pulleys.
(17) Tail raising screw.
(18) Tail raising drum.
(19) Tail wheel piston tube bearing * (2).
(20) Tail wheel piston pivot (4).
(21) Tail wheel hub bearing.
(22) Rudder hinges.
(23) Elevator control wire connections.
(24) Tail plane pivot.
(25) Rudder bar bearing.*
(26) Rudder bar link pivots.
(27) Rudder bar pivots.
(28) Mixture pulleys.
(29) Brake gear pulleys.
(30) Aileron cable connections.
(31) Differential control bearings.*
(32) Elevator cable connections.
(33) Throttle control pulleys.
(34) Brake gear pulleys.
(35) Throttle control pulleys.
(36) Throttle control pulleys.
(37) Throttle control pulleys.
(38) Aileron control pulleys.
(39) Aileron control pulleys.
(40) Aileron hinges.
(41) Aileron control pulleys.
(42) Aileron control pulleys.
(43) Elevator hinges.
(44) Fin trim drum.
(45) Fin trim screw.
(46) Rudder cable connections.
(47) Servo cable nections.
(48) Brake gear links.
(49) Mixture control pulleys.
(50) Aileron tie rod connections.
(51) Rudder servo hinge.
(52) Aileron pulley bearing.*
(53) Aileron con. rod connections.
(54) Tail trim bearing.*
● (55) Dual control rudder con. link.
○ (56) Control column extension heads.
● (57) Mixture control pulleys.
● (58) Mixture control pulleys.
○ (59) V.P. Airscrew control pulleys.
○ (60) V.P. Airscrew control cable connections.
○ (61) V.P. Airscrew control cable connections.*



IMPORTANT.

Points shown thus: ● should be lubricated with "Castrol Ease," "Castrol D," "Mobiloil CC" or similar.

Points shown thus: ○ should be lubricated with engine oil—"Castrol XL," "Mobiloil B" or similar.

Points marked thus: * need only be lubricated when aeroplane is overhauled for yearly "Certificate of Airworthiness."

All other points to be lubricated after twenty-five flying hours.

Number of grease gun nipples shown thus (2).

Fig. 31B.—LUBRICATION DIAGRAM.

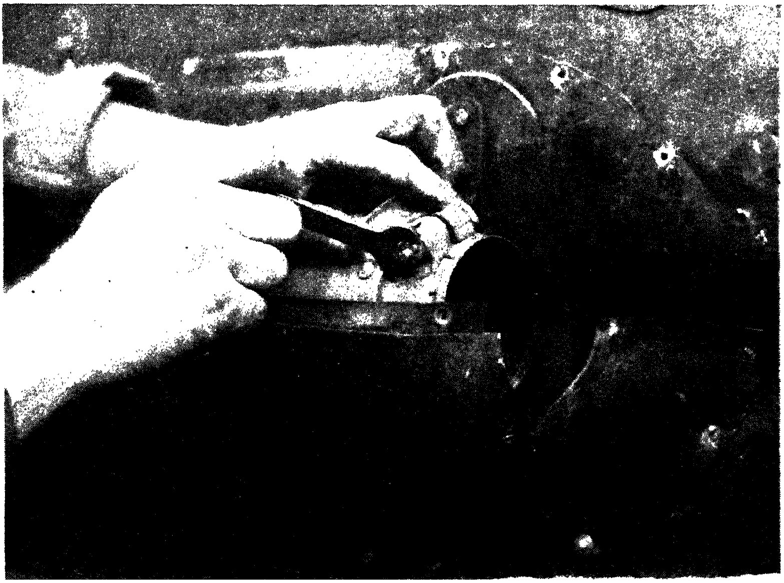


Fig. 32.—EXHAUST UNIT, CABIN HEATER MUST BE INSPECTED EVERY TWENTY-FIVE HOURS' FLYING.

To withdraw heater pipe, release the clamping ring.

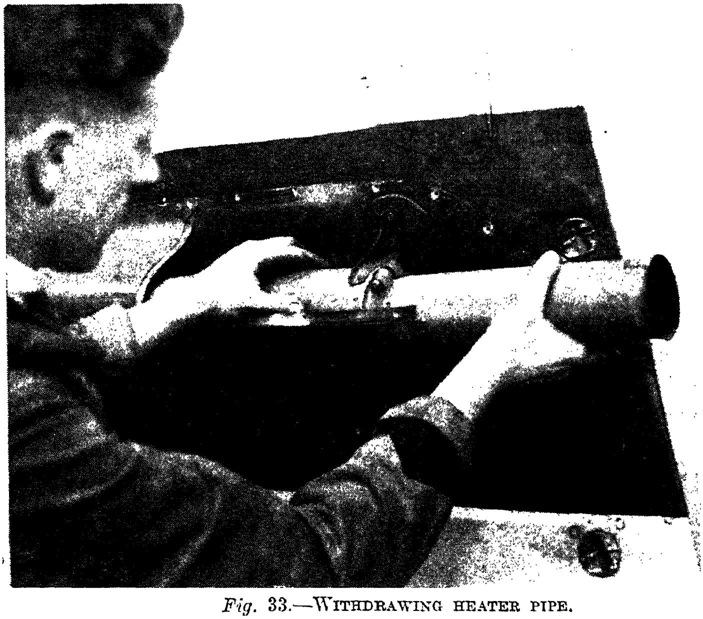


Fig. 33.—WITHDRAWING HEATER PIPE.

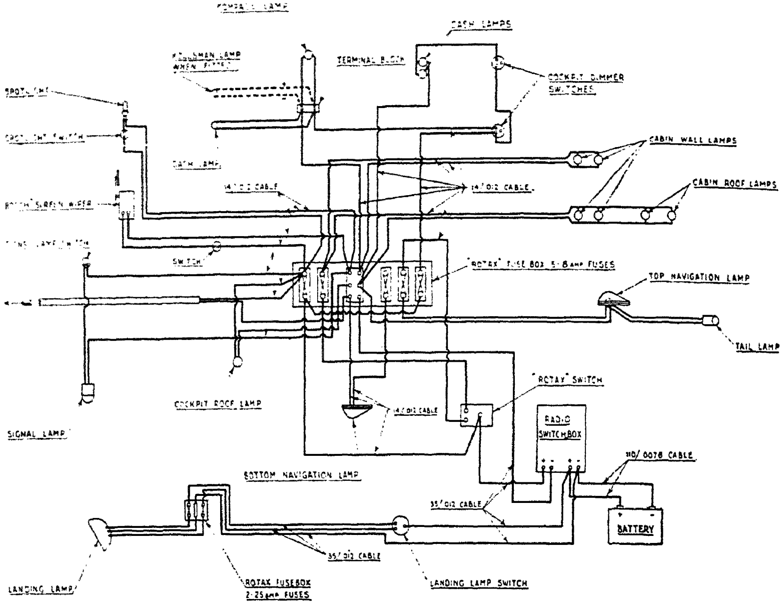


Fig. 34.—WIRING DIAGRAM FOR LIGHTING SYSTEM.

13. Check tightness of airscrew bolts (fixed-pitch airscrews). This should be done more frequently if the wooden airscrews are new or if the aeroplane is operating in a hot climate.

14. Attention to electrical equipment such as generators, cleaning of commutators, brushes and accumulators.

15. Run engines.

16. Where controllable-pitch airscrews are fitted. These must receive attention as recommended by the manufacturers.

17. (86 A and 86 B). Examine exhaust units of cabin heating system.

Note.—Where " zipp " fasteners are provided to facilitate inspection, it is inadvisable to leave these in a released position for long periods, such as overnight, as the doped fabric has a tendency to contract and a big strain would be imposed on the fastener when attempting to close.

The above schedule is intended to apply when twenty-five hours' flying is completed in a normal period of time.

If the period is unduly long, additional ground engineer's inspections are advised. The same advice applies should the aeroplane experience rough usage or abnormal conditions or show symptoms of irregular running.

After 250 Hours' Flying

The " Auto-Klean " filter should be dismantled and cleaned.

After 600 Hours' Flying

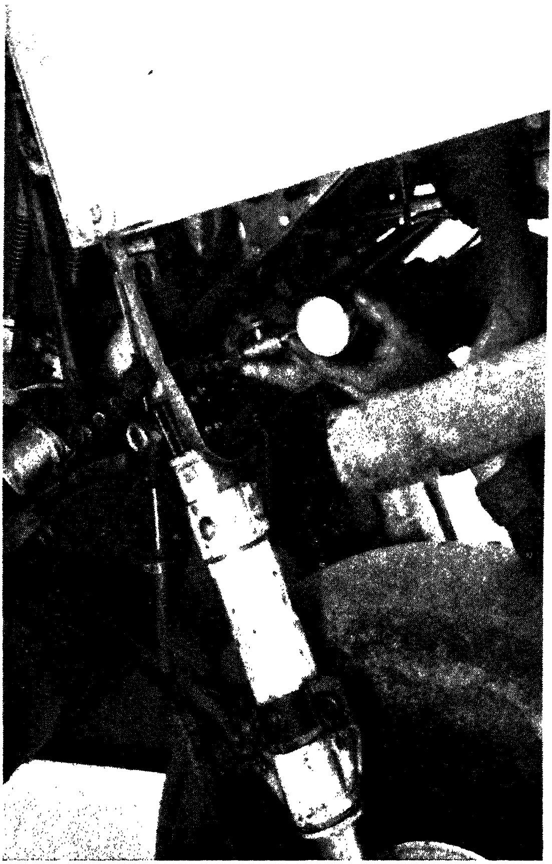
The engines should be taken from the airframe and given complete overhauls.

Annual Overhaul

It is recommended that the annual overhaul for the renewal of the certificate of airworthiness be carried out by a thoroughly competent servicing organisation.

Inspection of Pilot's Safety Belt

The safety harness should be periodically inspected. Should there be any suspicion of deterioration in strength it should be proof-loaded.



ig. 35.—CHECKING PRESSURE OF AIR IN LANDING LEG WITH PORTABLE GAUGE.

" DOWTY " PATENT UNDERCARRIAGE LEG

The construction of this leg is extremely simple and there is only one moving part, the bottom telescopic tube.

Maintenance

A charge of oil through the nipples should be given during the 25-hour maintenance routine. A spring and clamping bolt is provided to give additional longitudinal braking on the shock absorber springs. Care should be taken to see that this spring is never closed solid and the minimum amount of compression should be placed in this spring consistent with smooth taxying.

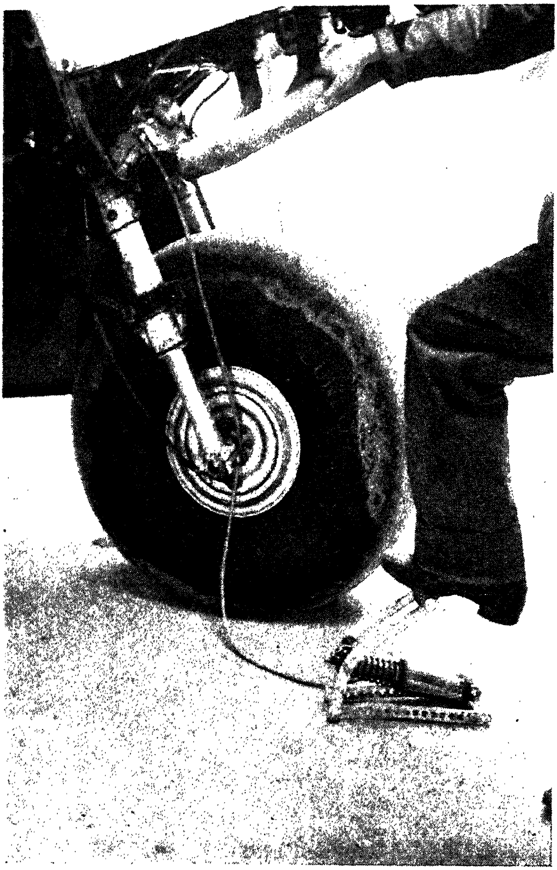


Fig. 36.—THE LEG IS FILLED WITH AIR FROM A SPECIAL FOOT PUMP (OR COMPRESSED AIR BOTTLE).

Dismantling and Replacement

The leg should be dismantled periodically or when there is any doubt regarding the functioning.

1. Remove bolts, top socket and top spring.
2. Remove two bolts and slide bottom telescopic tube off lower fitting.
3. Remove three bolts. This will permit removal of lower fitting. The leg can now be completely dismantled.

Points for Special Attention

(*a*) Wear on bronze liners.

(*b*) Wear on main sliding tubes and small centre tube.

(*c*) Wear on friction cones.

TURNER COMPRESSED AIR LANDING LEG

Maintenance

Daily.—Check length of piston rod to ascertain that no loss of pressure has occurred. Care should be taken that the aeroplane is on level ground and is standing evenly and is not binding on one side.

If necessary rock the aeroplane by moving the wing tip to release any tendency to bind in the legs. If loss of air pressure appears to have occurred check air pressure with pressure gauge either with leg fully extended or at the ascertained pressure when standing with no load.

After 75 to 100 Landings

Inject fresh Turner oil into the leg with the pressure oil gun: $\frac{1}{4}$ of

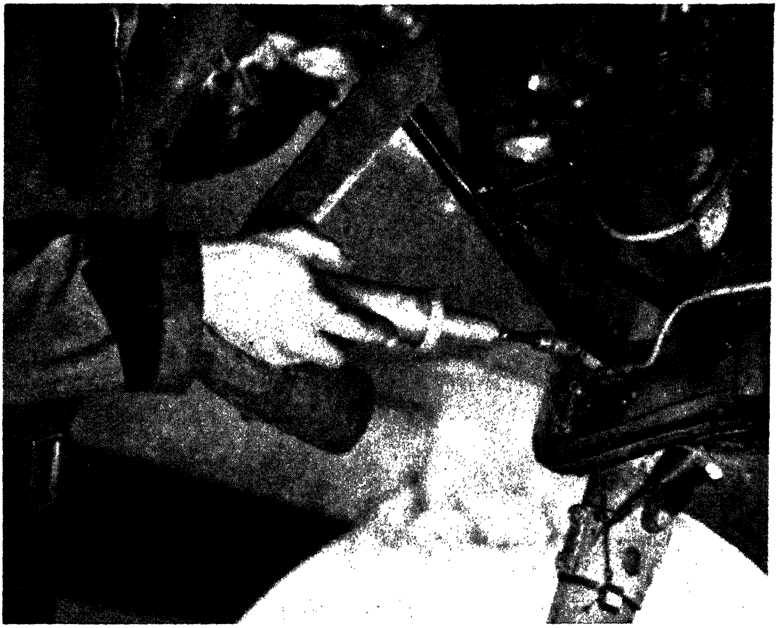


Fig. 37.—OIL MUST BE INJECTED TO LUBRICATE GLANDS DURING ROUTINE MAINTENANCE.

an oil gun will be sufficient for sizes 0–1, $\frac{1}{3}$ for size 2, $\frac{1}{2}$ for size 3, $\frac{2}{3}$ for size 4. When the aeroplane is out of commission for periods, fresh oil should be injected before flying. Should air escape while using the pressure oil gun, the leg should be refilled and rechecked with the air pressure gauge.

The lubricator at bottom of cylinder or on the gland nut should be lubricated at similar intervals with the cycle oil gun. Lubrication should be attended to regularly. Too little oil causes gland wear and leakage—too much oil affects the landing qualities of the leg.

Reasons for Air Leakage

The Turner compressed air leg will not leak if maintenance is correctly carried out. Should air leakage occur the following should be examined :—

1. The glands.
2. The valve.

1. *Leakage at the Glands.*—Air may escape at the bottom gland nut and can be detected by an application of soapy water. This may be caused by lack of lubrication. If this fails to effect a cure gland adjustment may be necessary.

Fig. 38.—CHECK THE LENGTH OF PISTON TUBE IN ACCORDANCE WITH DATA PLATE ON LEG.

With the special "C" spanner and with the aeroplane in the standing position adjust the gland nut inward with fairly hard pressure with one hand on the spanner. Only a very small amount of adjustment will be possible, probably less than ½ in. of movement.

2. *Leakage at the Valve.*—The air seal is obtained by a moulded rubber of special composition combined with a copper conical seat. In course of time this rubber may become worn and need replacing. Alternatively, the bore of the rubber seat may become enlarged and move over the valve when the latter is pushed inward. Should this occur air will not escape from the valve when opened, or no pressure will register on the pressure gauge. Opening the valve two or three times with the means provided with the pressure gauge will usually free the rubber, but should this not open the valve, the valve rubber should be replaced.

Before removing valve from cylinder the air in the landing leg must be released. A safety tab washer surrounding the valve must be removed before the valve can be unscrewed, and added as an extra precaution a warning plate is attached to the landing leg just under the valve.

It should also be noted that if the valve body is insufficiently tightened on its thread into the cylinder head air will escape round the thread and washer.